POWER PLANT ENGINEERING

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New Steam Plant at Amsterdam

ADIRONDACK POWER AND LIGHT CORPORATION CONSTRUCTS RELAY PLANT FOR HYDROELECTRIC SYSTEM

SERVING THE EAST CENTRAL part of the state of New York is an electric power system operated by the Adirondack Power & Light Corporation. The transmission lines form a network consisting of 300 mi. of high voltage lines connecting 21 substations supplying five cities and 25 other municipalities and serving a population of about 700,000 people occupying the district between Lake George and Lake Champlain on the north to Watervliet, Troy and Albany on the south, and from Vermont on the east to beyond Oneida on the west. The construction of less than 10 mi. of line on each end of the system would tie together lines of several companies extending from Detroit to Boston.

Until about 2 yr. ago this district was served by several independent power companies which at that time were brought together into the Adirondack Power & Light Corporation. Since then efforts have been made to make those diverse smaller properties operate as one system; in another year it is hoped that the system will be well established and the larger development can be built on the foundation thus prepared.

In this system are eight power plants having a total capacity of 100,000 hp. with an additional 40,000 hp. available from plants of other companies connected to

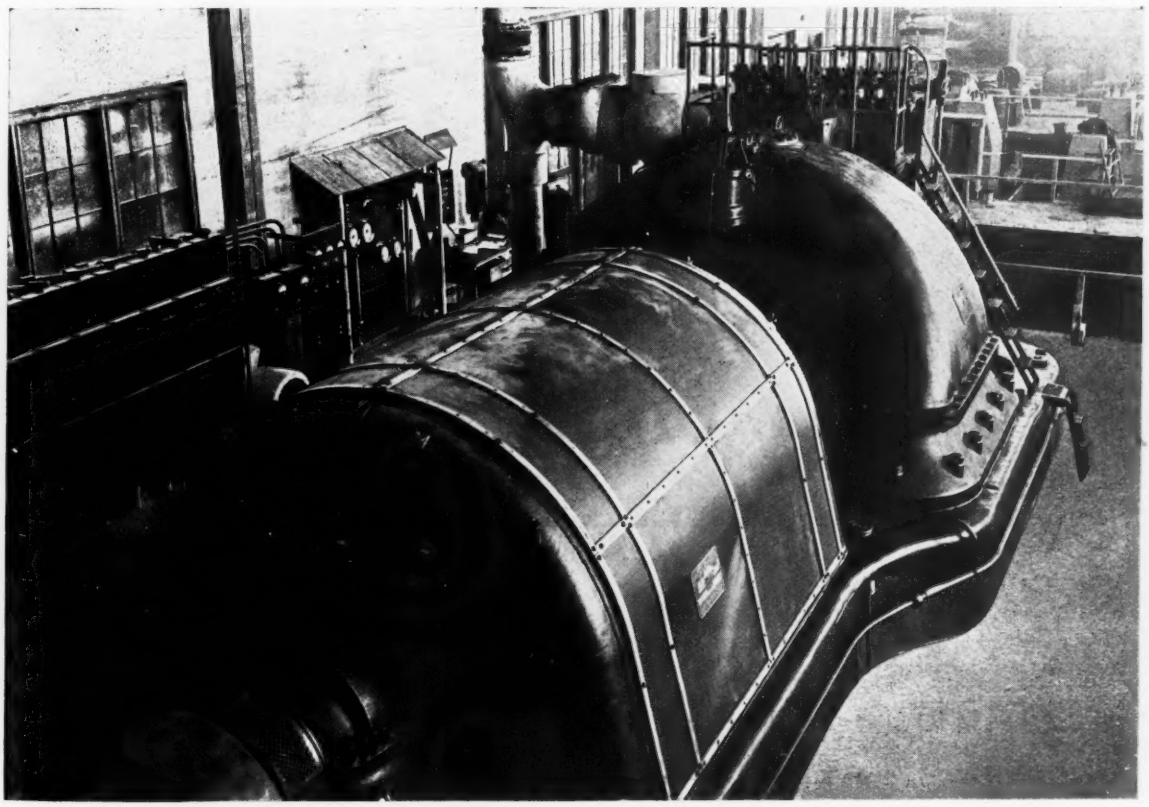


FIG. 1. FIRST GENERATING UNIT TO BE INSTALLED IN THE AMSTERDAM STEAM PLANT

the lines of the Adirondack Power & Light Corporation whose total installed capacity is about 140,000 hp. Taking a look ahead, the corporation selected a site about 3 mi. east of Amsterdam on the south side of the Mohawk River for a steam turbine plant with an ultimate capacity of 200,000 hp. the first unit of which has been in operation since last October and the second unit will be ready for service before fall.

This location was selected because of its nearness to the load center of the system, abundance of condensing water and railway convenience. The main building is of structural steel and reinforced concrete 166 ft. 5 in. long by 157 ft. 9 in. wide, designed to house two 15,000-kw. steam turbines and necessary boilers, pumps, condensers, etc., and may be extended to house ten or more such units. All water used in the plant is pumped through the crib house which is a reinforced concrete structure 70 ft. 6 in. long by 47 ft. 6 in. wide and is carried 37 ft. below summer pool level in the barge canal so as to secure a sufficient depth of water in the winter when the canal level is lowered. The present structure is large enough to house necessary equipment for development of 50,000 kw. and may be extended as conditions warrant.

Over the coal storage space and railway siding, a gantry crane serves to unload coal from cars, delivering it either to storage or to the bunker over the firing aisle in the boiler room. This crane spans 140 ft. and carries a 3-T. bucket, being carried on steel bents at a height of 68 ft. above natural ground elevation.

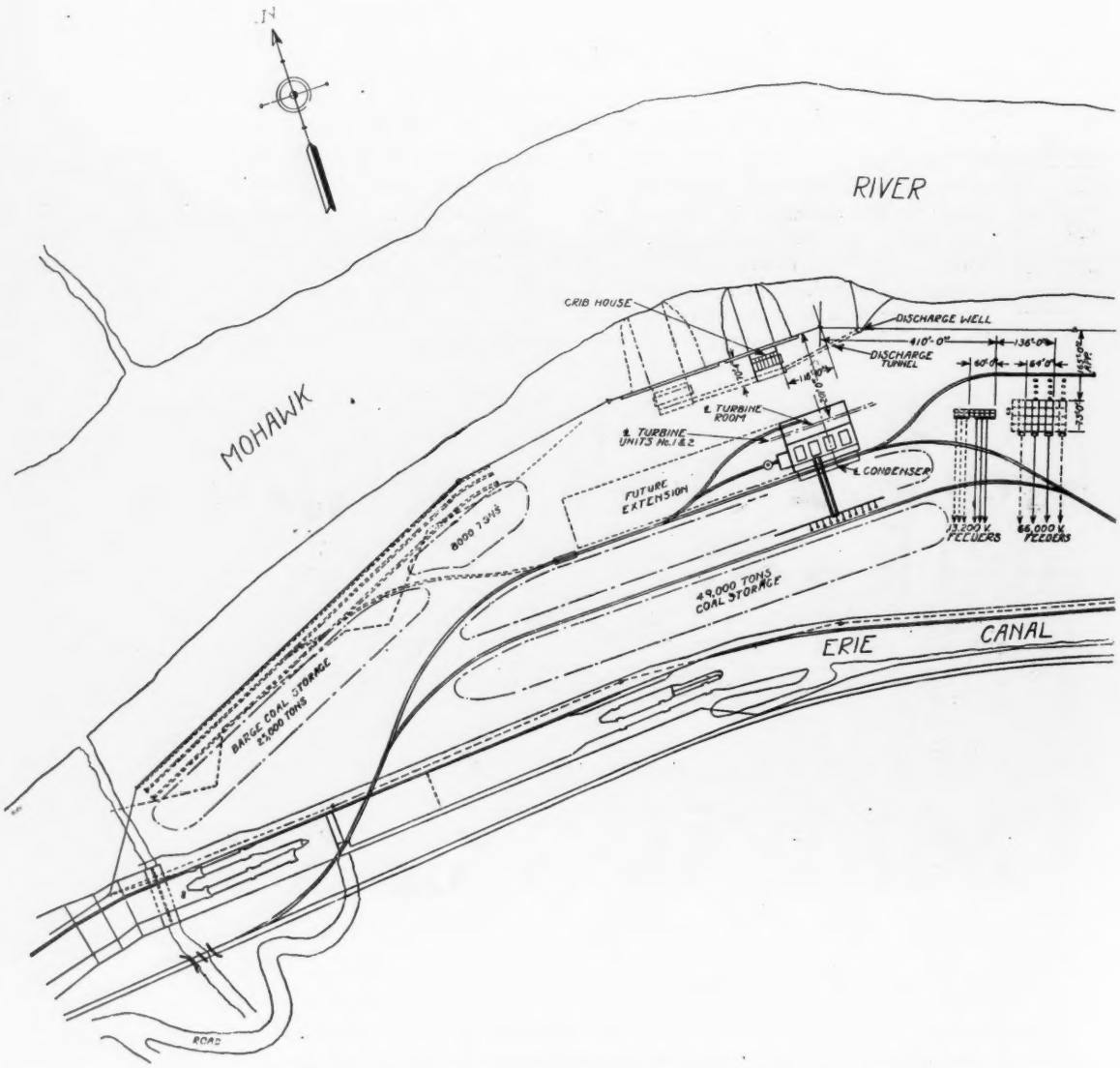


FIG. 2. PLOT OF AMSTERDAM STEAM PLANT SHOWING LOCATION OF BUILDINGS, SWITCH YARD, COAL STORAGE AND RAILWAY TRACK FACILITIES

Two outside switching structures are built in the yard east of the main building both of which may be extended as conditions require. One of these carries the equipment for the 66,000-v. line to Schenectady and the other 13,000-v. equipment for controlling power to Amsterdam.

Boiler Room

In conformity with modern practice, this plant is built on the unit plan. Each unit consists of one turbine generator and two boilers with their necessary auxiliary equipment, one unit now being in operation and the second nearly completed.

Although classed as one boiler each setting really contains two Babcock & Wilcox boilers, independent of each other so far as steam and water connections are concerned but both must be operated together, as they have but one furnace and there is no division wall between them though served by two traveling grate stokers. The combined heating surface is 13,445 sq. ft. which gives the boiler a rating of 1345 hp. The tubes are 4 in. in diameter and 20 ft. long and arranged 14 rows high by 42 wide, making a total of 588.

There are six drums, each 42 in. in diameter and the steam pressure carried is 275 lb. (300 lb. being the maximum for which the boiler is designed). Babcock & Wilcox superheaters are placed between the first and second passes of the boilers and at 200 per cent rating on the boilers will give 225 deg. of superheat to the steam.

The boilers are located on only one side of the firing aisle with the outside wall well provided with windows on the other making an extremely well lighted and comfortable boiler room. A large dial Ashcroft pressure gage with a scale reading between 250 and 300 lb. and visible the whole length of the boiler room is located over the center of the aisle.

Coal used for the generation of steam is anthracite No. 3 buckwheat which is delivered to the premises in railway cars where it is unloaded by means of the Whiting gantry crane equipped with a 3-T. clamshell bucket. From the cars the coal may go to the storage space by the side of the track or directly to the concrete-lined, steel, boiler room bunker directly over the firing aisle.

Two coal chutes conduct the coal from the bunker to the hopper of each stoker of which there are two to each boiler setting. These are Coxe traveling grate stokers driven through worm gears on the rear shafts by individual motors. Forced draft is used and the fuel bed is sectionalized so as to give best control over combustion. Two turbo connoidal forced draft fans made by the Buffalo Forge Co. are installed back of the boilers and are driven by General Electric Co. motors. They supply the air for combustion through individual steel ducts.

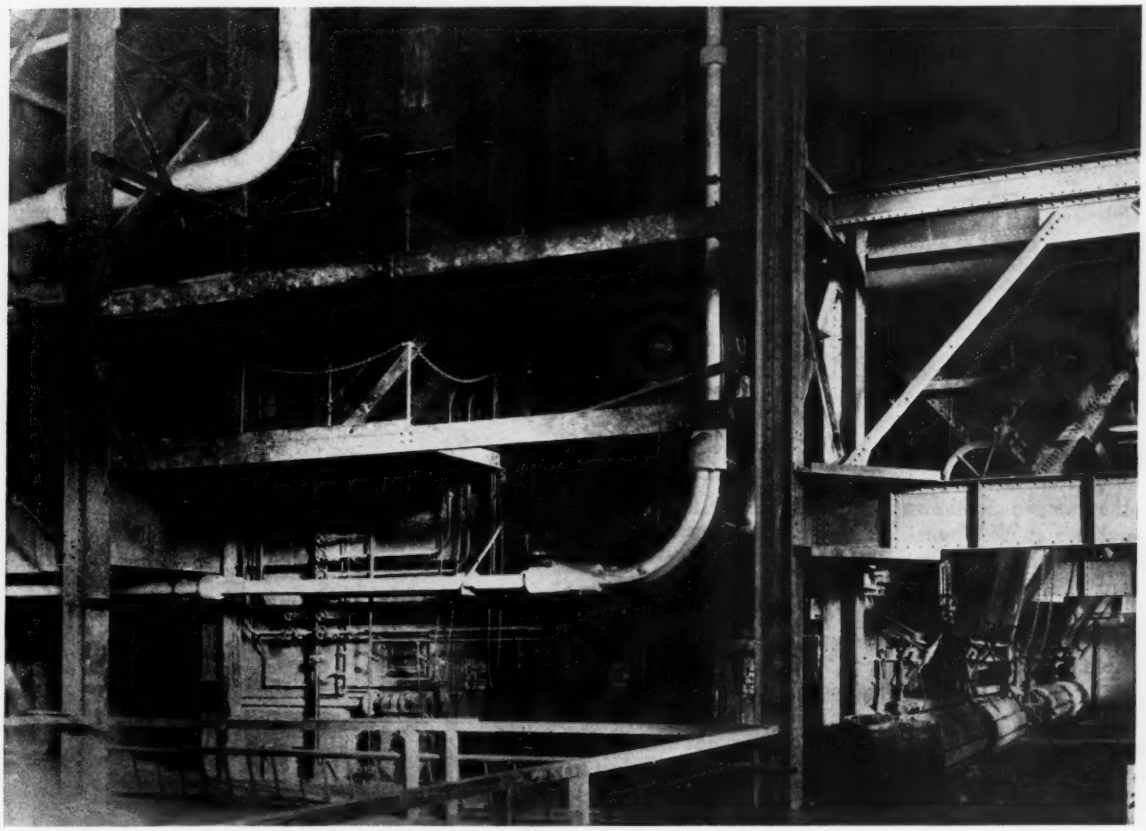


FIG. 3. BOILER-ROOM VIEW DURING CONSTRUCTION

In burning anthracite on this type of stoker one of the principal difficulties encountered is to obtain early ignition. This is secured by an ignition arch which in this instance is the Detrich type. Ashes fall over the end of the grate into a hopper, thence by gravity through an Arrow grate to a 200 cu. ft. Chillingworth motor driven skip hoist serving an elevated ash bin over a railway track.

One self supporting stack, mounted on the roof, serves two boilers. This was built by the Petroleum Iron Works and is of steel 175 ft. high above the grates,

lined with firebrick the entire height. The diameter at the base is 14 ft. 10 in. and at the top 12 ft. 10 in., this gives a stack area of 4.81 sq. ft. per 1000 sq. ft. of boiler heating surface. Induced mechanical draft is supplied by a Sturtevant fan serving each boiler. These are of the double inlet multivane type with water cooled bearings. The capacity of each is 6500 cu. ft. of gas against a static pressure of 4 in. of water, handling gas at 350 deg. F. temperature. The fans are driven by 200-hp. General Electric motors the rated speed of which is 514 r.p.m., but they are provided with control for variable speed from 50 per cent to full load speed. Draft in

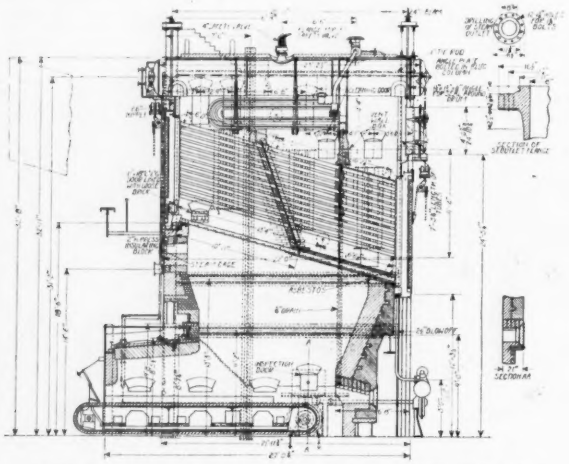


FIG. 4. LONGITUDINAL SECTION THROUGH BOILER

the furnace setting is regulated by hand, the air pressure carried in the duct and the intensity of the draft at the damper are shown by a Bailey meter mounted on the stoker control panel. To keep the tubes free from soot accumulation they are dusted once each watch by means of Diamond soot blowers.

Boiler feed water is principally return condensate from the surface condenser serving the main turbine, but make-up is drawn through Badger screens from the Mohawk River. All feed water passes through a Cochrane open heater, one of which is provided for each two turbines. It is made of steel 8 ft. in diameter and 20 ft. long and has a capacity of 400,000 lb. per hr. being heated by the exhaust steam from the steam driven auxiliaries and delivers the water at a temperature of 110 to 150 deg. F.

One feed pump is provided for each boiler, each of these being a four-stage Worthington centrifugal pump rated at 450 g.p.m. and given by a direct connected General Electric Co. steam turbine of 175 hp. rating at 2600 r.p.m. These pumps take the water from the heater and deliver it direct to the boilers under the control of S-C feed water regulators and pump governors.

Each boiler has six Yarway and two Edward blowoff valves, arranged so that each section of the boiler may be blown down separately through three laterals and one main valve. On each half of the boilers are four Consolidated pop safety valves, one on each of the three steam drums, and another on the superheater. These discharge through a common pipe extending through the roof.

Steam delivered by the boilers is measured by Bailey boiler meters and is carried in two 7-in. leads from each boiler to a 14-in. header. In each boiler lead, as a double protection against accidents is an Edward stop and check valve and a Crane emergency stop valve which is operated by an electrical release from several stations about the plant.

The main steam header is sectionalized by a hydraulically operated gate valve in order to give flexibility of control and the drips from each section are returned to the feed water heater by means of Crane-tilt traps. Steam is carried to the turbine in a 14-in. lead which is also provided with a hydraulic operated valve with a control station at the turbine. The piping work of the plant was done by the Pittsburgh Piping & Equipment Co., Sargol welded joints being employed on all high pressure steam piping 5 in. or more in diameter, and all steam piping is insulated with the standard thickness of 85 per cent magnesia.

Electric Generating Equipment

As previously stated one turbine generator has been in operation since last October and the second unit will be ready before fall. These prime movers are alike being General Electric Co. units designed to carry 15,000 kw. at 80 per cent power factor. The turbines have eight stages, run at 1800 r.p.m. and take steam at 275 lb. pressure, the temperature at the throttle being

FIG. 5. ASH BIN AND COAL CRANE AS SEEN FROM WEST OF THE PLANT

640 deg. The generators deliver three-phase current at 13,200 v. and 60 cycles. The guaranteed performance of the unit in 10.70 lb. steam per kw.-hr. Excitation is furnished by a 100-kw. generator direct connected to the turbine.

Oil circulated through the turbine bearings is kept cool by passing it through a Schutte & Koerting oil cooler, service water being used as the cooling medium, and a De Laval oil purifier is provided for use periodically to keep the oil in best condition for lubricating purposes.

These turbines are served by Worthington eccentric shell type surface condensers, fitted with inner air cooler and cast-iron hotwell, and supported on car springs directly beneath the turbines. The condensing surface has a total area of 25,000 sq. ft. being made up of 5080 1-in. tubes 18 ft. 3½ in. long, this gives 1.67 sq. ft. of surface per kilowatt rating of the prime mover.

The circulating pump is a 30-in. horizontal split case volute type, driven by a 300-hp. motor operating at 450 r.p.m. synchronous speed but with variable speed control, and the pump is designed to furnish 25,000 g.p.m. under normal operating conditions.

Apparatus for the removal of air and non-combustible gases consists of two No. 8 hydraulic vacuum pumps, the hurling water for these two pumps being furnished by an 8-in. split cast hurling water pump which is mounted upon the same bedplate with the hotwell pumps, both pumps being driven by a 100-hp. motor.

During the winter while the river is not used as a canal, the water level is lowered considerably which puts a suction head of about 10 ft. on the circulating pumps to elevate the water to the condensers. Provision is also made for recirculation of the water during the winter to prevent freezing.

Air used for cooling the generator is drawn from the basement of the turbine room being first washed and cooled by a spray of water in a Badger air washer before circulating through the generator coils, or may be recirculated.

House service water which is used for all purposes except drinking is taken from the river through Badger strainers and delivered to a 5000-gal. tank on the roof of the building. For handling this water, two 4-in. Worthington centrifugal pumps are installed in the crib house. These are driven by direct connected motors at a speed of 1750 r.p.m. and have a capacity of 750

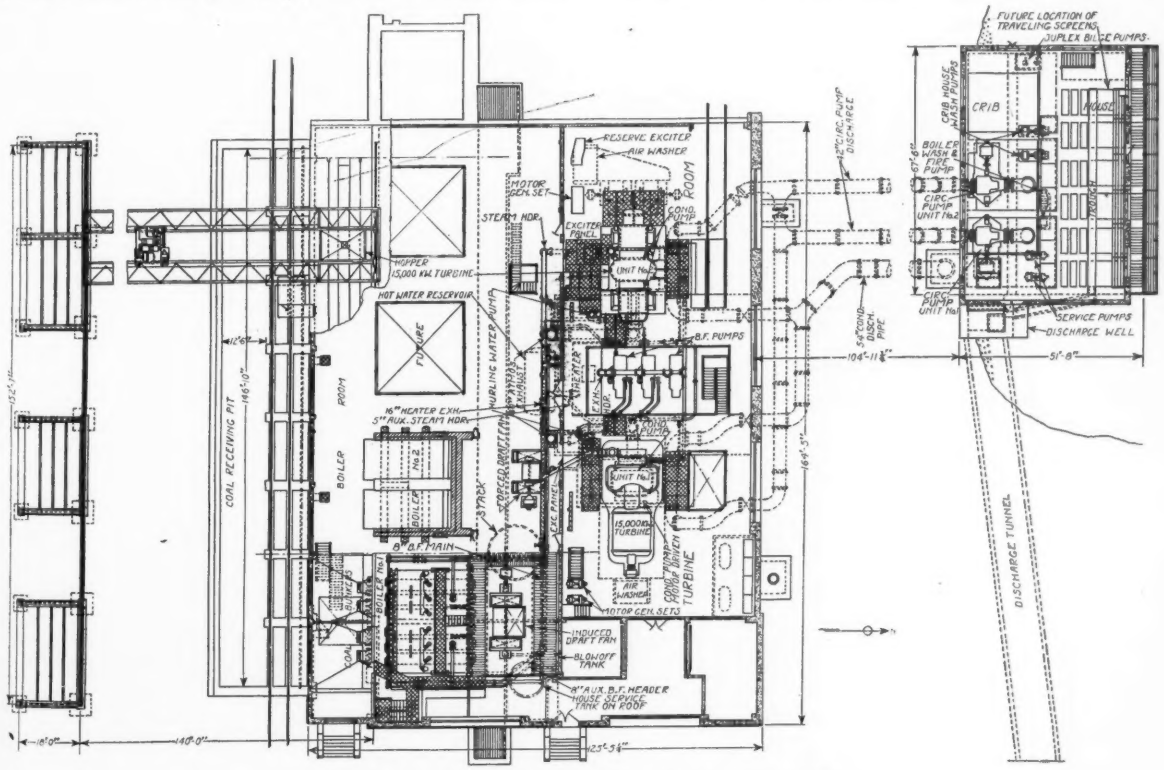


FIG. 6. PLAN OF THE POWER PLANT AND CRIB HOUSE

There are two of these combined hydraulic supply and hotwell pumps units, one of which is motor driven and the other driven by a 100-hp. General Electric Co. turbine. Each hotwell pump is a 4-in. two-step contrifugal split case type.

Condenser and auxiliary equipment is all of Worthington make and was designed to condense 165,000 lb. of steam per hr. and to maintain 1½ in. absolute pressure of mercury in the condenser when supplied with 25,000 gal. of circulating water per min. at a temperature of 70 deg. F. The circulating water is taken from the Mohawk River which during the summer months serves as the New York Barge Canal. At present stationary screens are used as the water is quite clear of trash but provisions have been made for traveling screens to be installed in case they are found desirable.

g.p.m. There is also a screen-wash pump placed in the crib house, it is of the same make and size but its capacity is only 500 g.p.m. and the motor driving it is 50 hp.

The pump provided for fire protection is also used for washing the boilers. It is a 4-in. four-stage Worthington centrifugal pump driven at 1750 r.p.m. by a 200-hp. General Electric induction motor.

Compressed air is used about the plant principally for cleaning electrical equipment being supplied at 100 lb. pressure by a Worthington Laidlaw feather valve type air compressor driven by belt from a motor.

Electric Control Equipment

At the east end of the turbine room is the electric control equipment, the station switchboard being located on the third floor overlooking the turbine room through

a window glass partition and with clear glass sections in the window to the east of the building giving a view of the outdoor transformer stations.

All main circuits are of course controlled by remote control switches the current for which is furnished by a storage battery charged by a motor generator set. The switchboard equipment consists of a benchboard for the

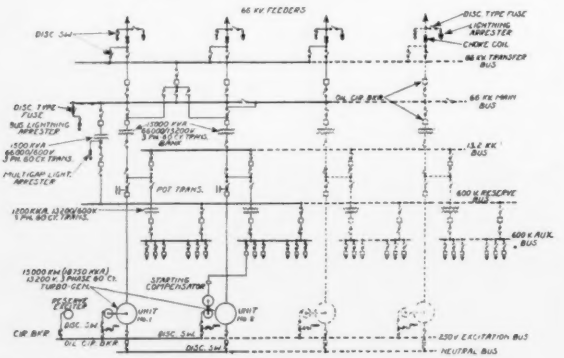


FIG. 8. ELECTRICAL DIAGRAM OF MAIN CIRCUITS

control of the generators and the main busses and several upright boards conveniently located for controlling outgoing and auxiliary circuits.

Among the features of special interest about the control apparatus are a mimic bus on the benchboard, interlock requiring that synchronizing plug must be pushed into its receptacle before the switch can be operated, plug switches to indicate temperature of generator

fourth floor contains the storage battery consisting of 60 Exide cells of the submarine type six of which are end cells. These furnish direct current for operating the remote controlled switches and for emergency lighting. The motor generator set which charges the battery is a 25-kw. General Electric unit run at 1800 r.p.m. furnishing current at 170 v. located on the turbine room floor.

On the fourth floor are also the generator rheostat and the station lighting transformer and induction regulator. This is a 75-kv.a. transformer with a transformation ratio of 550 to 110 or 220 v.

The fifth floor will serve as a lodge room and kitchen for the employes.

For supplying power for motor driven station auxiliaries there are provided two 3-phase, 13,200 to 575-v. 1500-kv.a. transformers. These are connected on the high tension side to the main generator leads through disconnecting switches and G. E. type H-6 oil circuit breakers. The low side of these transformers is connected to the main station auxiliary bus through disconnecting switches and G. E. type K-34 oil circuit breakers. This main auxiliary bus is sectionalized through disconnecting switches and a G. E. type K-34 oil circuit breaker. The purpose of this sectionalizing switch is to have the auxiliaries for each unit on a different section of the bus. Normal operation is with the bus section switch closed. The larger station auxiliary motors are fed by separate feeders through disconnecting switches and G. E. type K-32B oil circuit breakers from the main auxiliary bus.

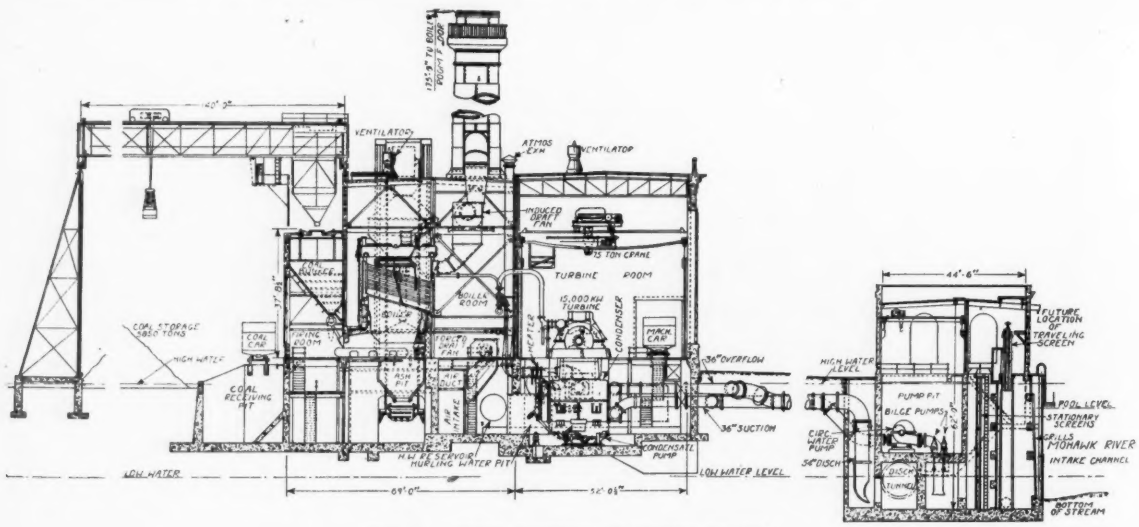


FIG. 7. CROSS SECTION OF POWER PLANT

and transformer coils, water flow and temperature alarms on transformers and Holtz Cabott 70-drop enunciator giving warning when circuit breakers open.

The rules of the plant require that the switchboard operators on duty shall not leave the switch room so they are provided with a first aid kit, a private lavatory and electric cooking devices to be used as needed.

This section of the building has five floors, the switchboards, as previously stated, are located on the third floor while the conduits containing the main station switches and busses are on the floor beneath. The

There are several groups of small station auxiliaries which are fed from feeders from secondary busses. These secondary busses are located in the boiler room, turbine room and crib house, and are fed by single feeders from the main auxiliary bus through disconnecting switches and G. E. type K-32B oil circuit breakers. The feeders for the small auxiliaries that are taken from the secondary bus are connected through the V. V. Fittings Company safety switch to the bus. These safety switches are arranged in groups of four high and from three to six long, the bus running horizontally between the sec-

ond and third switches. This arrangement makes a very neat appearing and convenient method of control for these smaller units. The oil circuit breaker controls for the larger station auxiliaries and for the secondary buses mentioned are located in the immediate vicinity of the particular piece of apparatus to be controlled.

To the east of the power plant one of the outdoor high voltage switching stations controls the current at 13,200 v. transmitted over three lines to Amsterdam

FIG. 9. CORNER OF SWITCHBOARD ROOM SHOWING METER PANELS, ENUNCIATORS AND BENCHBOARD

and the other station is provided with three single-phase, 5000-kv.a. General Electric Co. transformers which boost the voltage from 13,200 to 66,000 for transmission over a single line to Schenectady, and another circuit going west to Inghams hydro-electric station and which will be extended to Utica. A second circuit to Schenectady is now being built. From Schenectady a double circuit is being run southeast to connect at Ravena with the system of the United Hudson Electric Corporation. The transformers are connected delta star with grounded neutral.

For convenience in handling the loads at the various plants of the system, the company maintains its own private telephone system with local stations at important points about each plant.

The engineering work on this plant was done by Sargent & Lundy of Chicago, and the entire construction work was carried on by the Adirondack Power & Light Corp., to both of whom we are indebted for blueprints and information which has made this article possible.

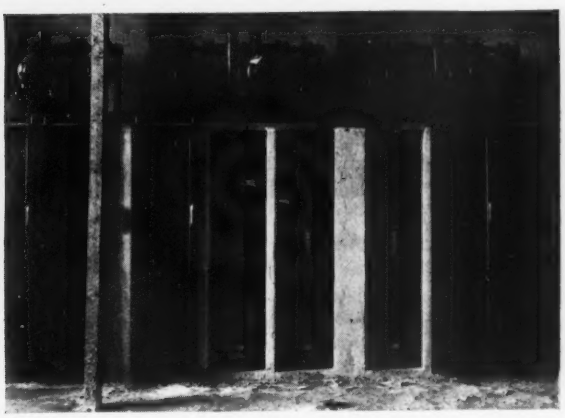


FIG. 10. REMOTE CONTROLLED SWITCHES FOR 13,000-V. SYSTEM

Some Modern Boiler Feed Control Ideas

By W. F. Schaphorst

AS IS well known by most engineers, boilers today do not store as much water as they once did. As the volume is being reduced the steam output per minute is becoming greater per pound of water stored. Modern boilers are more and more approximating the "flash" type of boiler, which means that the boiler must be fed more nearly in proportion with the steam output than has been the practice in years past.

Since it is absolutely necessary for feed water to flow into the boiler almost as rapidly as the steam flows out and since boilers are approaching the flash type, it is plain that boiler feed regulation should be purely a machine function and should not be done by hand. A delicate adjustment of boiler balance should not be left to an ignorant water tender, or even to an intelligent water tender, but rather to a dependable automatic mechanical regulator. It has been correctly stated that the most famous mechanical engineer alive cannot compete in efficiency with a good mechanical regulator. High boiler ratings, high furnace temperatures and small water storage space altogether require a very sensitive and almost perfect water level adjustment.

It is not very well known among the profession, but it is a fact that the water gage glass indicates every conceivable change in the operating conditions, such as pressure changes, temperature changes, stoker changes, etc. Instantaneous changes in operating conditions are shown in the gage glass, consequently water level is a function of instantaneous changes in operating conditions. For this reason, a steady level with variable load is wrong, and so is a variable level with a steady load. If the load is variable, the water level should be variable, and if the load is steady, the water level should be steady.

Because of these variable conditions in modern boiler practice, we are bound to have wider variations in water levels than were obtained a few years ago, but we still find engineers as well as water tenders trying to maintain an absolutely constant water level which certainly is wrong in most instances. It is time to break away from these old practices and establish new practices more in line with the requirements of the modern semi-flash type of boiler. Thus longer water columns might be advisable in many cases, particularly on boilers having but little water storage space. The water level is going to vary anyway because of load conditions, hence we may as well accept the inevitable.

Where should the operating water level be maintained? Many engineers will answer, "At the center of the drum, because old time convention has fixed it at the center." This level, however, is being found too high these days, particularly in steam turbine plants. Oftentimes the position of the water level in the glass does not give the true height of the water in the drum and as a result slugs of water go over into the machine and a wrecked turbine results. In many boilers, the average water level should be dropped from one to two inches. Four years ago, considerable trouble was experienced in a large power plant because of water going over into the turbine. By maintaining a lower water level and mechanical boiler feed regulation, all water trouble was overcome.

Many steam power plants are also lax in the carrying of proper pressure in the boiler feed line. Here again past practice has dictated that the pressure shall be high, because high pressure was originally employed for hand feeding which was more or less spasmodic, and therefore required a high pressure to get the water to any boiler in case the water tender was asleep on his job. High excess pressures cause unnecessary strains and wear on feed lines, fittings, pumps, etc. High pressures are no longer necessary. Continuous feed does not require high pressure because the regulators are active all the time.

On large boilers two regulators should be installed to take care of the differences in operating conditions and properly to distribute the cold water.

During the past year there has been a tendency to insist that regulators shall be indicating; that is, the regulator must indicate the amount of valve opening, thus permitting the operators to check up with the water glass level. There is also a belief on the part of many users that a regulator with a fireman casually looking at the glass is safer than the employment of a water tender who is supposed to do nothing but look at the glass. A regulator that can be cut out quickly and easily and that is simple to understand and get at will get the co-operation of the operating force, and co-operation, of course, is always necessary.

The use of feed water regulators has increased to such an extent that they are now used in a large majority of steam plants regardless of size. This great increase in their use is due to the development of a system of feed which is continuous as long as there is a load on the boiler and which automatically raises the water level during light loads and lowers it during heavy loads, so as to increase steaming capacity. This system has produced fuel savings varying from three to eight per cent and at the same time by eliminating the uncertain human element has greatly increased the reliability and safety of operation.

Regulators should be so constructed that the water level can be raised or lowered quickly while the boiler is under load.

Each regulator should be designed for the conditions under which the boiler is to operate. Each valve should be sufficient in size for the maximum requirements plus a reasonable factor of safety, but the valve size should not be excessive or overfeeding or intermittent feeding will result.

Where the boiler feed pressures are 275 lb. or over the outside walls of those parts of the regulator subjected to that pressure should be made of cast steel.

Where bad water conditions are encountered the internal valve parts should be made of monel metal.

To insure full feeding, a high lift valve should always be specified.

The feed valve should be so designed that the feeding will always be smooth at all loads even up to the maximum rating.

Gage glasses do not always indicate correctly because that side of the drum receiving the cold water will have the lower level. The level is lower because the water is heavier per cubic inch and because steam bubbles which always move in an upward direction are not contained in it. The water level in a boiler is composed of two components:

1st. The level due to the actual volume of solid water, which is called the weight level.

2nd. The level due to the volume of mixed water and steam, when operating, which is called the volume level.

The boiler should not have too small a liberating surface and should not be subjected to "geyser action." If good dry steam is wanted and dangerous water floods are not wanted, the regulator should be properly connected and adjusted to the drum and the water glass should be so connected that it will not register a false level. The glass should register approximately the highest level that occurs anywhere in the drum. Longer gage glasses should be used than are now common in modern practice.

Oiling Steam Turbines

Some Difficulties, How to Overcome Them and the Proper Oil to Use

IN THE lubrication of turbines, certain troubles are encountered, due to the infiltration of water through the glands, accumulation of dirt and sediment and to some extent, impurities brought over with the steam.

Before starting up a turbine, the oil piping system should always be blown out with air to clear all the dirt, scale and chips which may have accumulated during installation, and it is a good plan when changing oil in the system to blow out again, but it is usually difficult to do so and will not be as effective as the first time on account of the pipes being wet with oil. Also most of the foreign matter will be carried out with the oil current and accumulated in the bottom of the settling chamber.

To get rid of the water, it is necessary first to use an oil which does not readily form an emulsion with water; second, to have a water trap at the bottom of the oil reservoir into which the water can settle. This should be drained at regular intervals to take away the water, the frequency depending on the amount of water which is found in the trap.

Circulation of the oil in a turbine oiling system is usually rapid, and the flow and churning tend to mix air with the oil so as to form bubbles, especially if the oil is quite warm. As the oil bubbles break, there is a certain amount of oil carried with the air into the space above the oil, thus causing a fuming loss; also there is a tendency of the air to oxidize the oil creating a carbon

sludge. The remedy is the use of as light an oil as will serve to keep the bearing surfaces from metallic contact, cooling the oil, slow steady pumping and a rest period in the reservoir sufficient to allow the sludge to settle out. If the inside of the reservoir or any of the oil chambers is painted, the oil may dissolve the paint, assisting in the oxidation of the oil. It is better that the surfaces be not painted.

Cooling is accomplished by a tubular cooler, through the tubes of which the oil passes after leaving the pump, water flowing around the tubes to carry away the heat. The temperature should be kept as low as possible without going to too great expense.

Spite of all precautions, the oil will gradually become impure and it is necessary to adopt some means of replacing it. Adding new oil only dilutes the old, and while this has a tendency to throw down the sludge, which may then be partly drawn off from the settling reservoir, the time will come when the oil must be renewed. A somewhat better plan, which will prolong the period between renewals, is to draw off part of the old oil and replace it with new, sending that removed to the filter for reclaiming. A third method is to keep a surplus of oil in the system so that the entire lot can be run until it gets to a condition where replacement is necessary. This avoids mixing fresh oil with old, but before the end of the useful period, all the oil in the system has become more or less unfit for use.

Continuous filtration, by drawing a part or all of the oil through a filtering system at each passage through the system will remove most of the troubles, and in a system so treated the oil has been known to remain in good condition for years, new oil being added as the supply decreases. The system used may be that of settling trays and filtering bags, or that of removing the water and dirt by centrifugal separators, but in either case it is better to treat the oil while it is hot, and cool it before it is sent to the oiling system.

As to the oil to be used: Regardless of the service, the oil should be low in volatiles, a good conductor of heat, so tenacious that a film will not easily be broken, slow to emulsify with water and easily separated from water, if emulsification has taken place, and of such character that it will not lose its viscosity at high temperature, that is, will not become thin and watery.

Given these qualities, the grade of oil to be used will depend on the speed and load to be handled. For high-speed bearings such as are found on the smaller turbines, a light turbine oil is best as it gives up heat readily and is easily cleaned of sediment. It is, however, light bodied and does not give a heavy enough film for gear-drive turbines or those of medium speed and weight. For such, a medium turbine oil should be chosen.

In the case of large turbines, which run at comparatively slow speed and are of great weight, it is necessary to use heavy turbine oil, though this has the disadvantage of being slower to clean, giving up heat less readily and easier to oxidize. But the first consideration is that the oil film must be maintained in the bearings, and the oil must have enough body to do this regardless of other considerations.

One kink which will assist in keeping the oil free of impurities is to keep the turbine blades clean. The lubricating oil does not enter the turbine case but some condensation from the case will seep into the bearings, and, if it carries with it matter from blade coatings, the oil will be sooner contaminated. Feeding to the case of one-half pint of kerosene per hour by means of a force-feed lubricator will help prevent the accumulation of scale and grease on the blades, and thus improve conditions for both steam action and oil condition.

Continuous Blowdown and Water Purification Process*

Method of Precipitating Impurities Outside of Boiler Without Loss of Heat

IT IS unnecessary to recall the advantage of feeding boilers with hot water. In addition to those advantages due to the thermal side of the question, there are those produced by the reduced solubility of gases in water at high temperatures. Purification at ordinary temperatures, whether by the use of soda alone or lime and soda, requires considerable time, owing to the slowness of the reaction and the fineness of the precipitate formed, which settles slowly. The reduction in the time required for the same reactions in hot and cold liquids is shown in the curves, Fig. 1, which has been taken from a catalog published by Cochran & Co.

For enabling the speed of these reactions to be increased and to hasten precipitation in cold water, one process consists in bubbling through the sediment in the water to be purified after the addition of the reagents. Under the influence of the large quantity of old residues, the size of the particles that are formed increases; the small particles that come into existence are attracted by the larger ones that have already formed which absorb them, and this precipitate, which consists of much coarser material, settles much more rapidly. Owing to the increased speed of settling, the reagent quickly becomes poor in one of its constituents, and the equilibrium of the reaction is favorably disturbed. This process allows the rate of purification to be increased, and hence the dimensions of the apparatus can be reduced; but, on the other hand, a difficulty is generally introduced where agitation of the sediment is obtained by a stream of water which carries air with it. This causes a considerable increase in the amount of oxygen contained in the water that is to be purified; under the condition met with in practice, saturation occurs almost instantaneously and gives rise to corrosion in boilers.

In any process for softening water, a rise of temperature gives the following advantages:

1. Increase of the speed of reaction. 2. Diminution of the viscosity of the water. 3. Decomposition of the bicarbonate of the alkaline earths. 4. The diminution in the solubility of sulphate of calcium.

Continuous Blowdown

When a boiler, the feed water for which is purified

*Abstract of description given before the British Institute of Mechanical Engineers by M. Kestner.

by any method, has been running for some time, all the salts carried in with the feed water are concentrated in it. These salts are only alkaline salts when the water has been thoroughly purified, and the calcareous sediment of the water has been incompletely purified. In general, a definite amount of calcium carbonate always remains in solution in the water. When the concentration produced by evaporation become so high that, notwithstanding the rise of temperature, this carbonate remains insoluble, it is then deposited on the walls of the boiler and in the tubes forming incrustation, which is the harder the more slowly the deposit is made. In boilers generating steam rapidly, these deposits are formed more rapidly than in slow evaporation boilers,

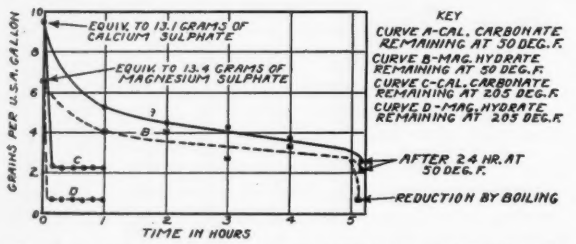

GRAINS PER U.S.A. GALLON
EQUIV. TO 13.1 GRAMS OF CALCIUM SULPHATE
EQUIV. TO 13.4 GRAMS OF MAGNESIUM SULPHATE
KEY
CURVE A-CAL. CARBONATE REMAINING AT 50 DEG. F.
CURVE B-MAG. HYDRATE REMAINING AT 50 DEG. F.
CURVE C-CAL. CARBONATE REMAINING AT 205 DEG. F.
CURVE D-MAG. HYDRATE REMAINING AT 205 DEG. F.
AFTER 2.4 HR. AT 50 DEG. F.
REDUCTION BY BOILING
TIME IN HOURS

FIG. 1. CURVES SHOWING REDUCTION IN TIME REQUIRED FOR THE SAME REACTIONS IN HOT AND COLD LIQUIDS

and notwithstanding the violent circulation of the water, sediment may accumulate in the tubes. These sediments give rise to overheating and to very hard incrustation.

To avoid these difficulties, in actual practice, the boiler is blown off. This water is at the pressure and temperature of the boiler, and, in blowing off, a large quantity of heat is lost. To be effective, blowing off must take place to the extent of a large actual quantity of water, though the amount is small in proportion to the total contents of the boiler. Continuous blowdown allows these calories to be saved. Instead of sending the blowoff direct into the drain, a relatively small quantity is caused to leave the boiler continuously from its lowest point. This water cools in giving up its heat to the feed water in a feed water heater of ordinary pattern; the mud is deposited in a trap; it loses in cooling a certain proportion of the salts which had been retained in solution owing to the high temperature of the liquid. Then, the salts which would cause incrustation, mud and deposit having been collected and removed, the liquid is mixed with the feed water and returns into the boiler.

It will thus be seen that there is no loss of heat due to the blowoff, and that neither deposition nor scale can be caused in the boiler. There is, however, another cleansing operation to perform. It is the removal of the mud deposit at the blowoff outside the boiler. This removal is only of small magnitude, because the apparatus in which precipitation takes place has a conical bottom suited to this purpose; and, further, the water in it is not under pressure; it removes only a few heat units because the blowoff is at this moment already considerably cooled. This small amount of extraction at low temperature suffices to limit the concentration of the soluble salts before danger from the raising of the boiling point of the water commences.

If the boiler has been blown down to the extent of 20 per cent of its contents in an hour, this means that its contents are renewed every 5 hr. This is impossible to effect by any other process, and it ensures the elimination of all mud that has been produced before it has time to accumulate. This shows the great advantage presented by the process of continuous blowing-down in itself, this advantage being twofold when the feed water is purified by means of soda; in fact, in this case, the calcium and magnesium bicarbonates contained in the water give, by double decomposition with sodium carbonate, sodium bicarbonate and calcium carbonates according to the reaction:

$$(CO_3)_2\ Ca\ H_2 + CO_3\ Na_2 = 2\ CO_3\ Na\ H + CO_3\ Ca.$$

The bicarbonate, which is unstable at the temperature at which the purification in hot water takes place, decomposes, at any rate partially, giving a neutral carbonate and carbonic acid gas, according to the equation:

$$2\ CO_3\ NaH = CO_2 + H_2O + CO_3\ Na_2.$$

The water which enters the boiler contains, therefore, carbonate and bicarbonate of soda. These salts are in quantities equivalent to the calcium salts that have been eliminated. In the boiler the bicarbonate is decomposed, giving a carbonate, as has been seen above, and then the carbonate in its turn is dissociated in the presence of water, giving caustic soda. There is thus another reversible condition of equilibrium in functions of the initial concentration on the one hand and of the temperature on the other. This may be represented in the following form:

$$CO_3\ Na_2 + H_2O = 2\ Na\ OH + CO_2.$$

Thus hydrolysis gives more caustic soda, the higher the temperature.

With continuous blowing-down, water containing caustic soda and carbonate of soda is therefore drawn from the boiler. If this solution be mixed with untreated water, the caustic soda and the carbonate they

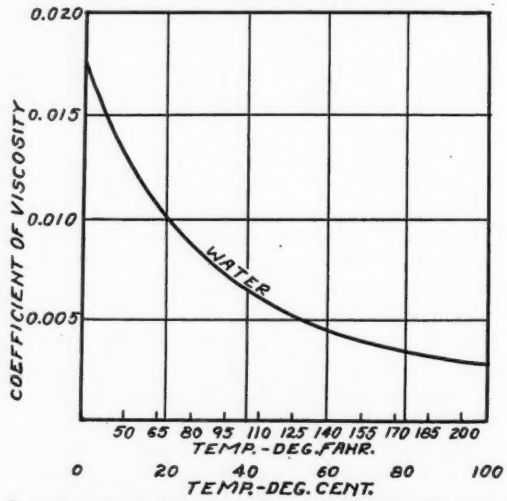


FIG. 2. VARIATION OF VISCOSITY OF WATER WITH CHANGES IN TEMPERATURE

contain will purify the water; the carbonate in the same manner as previously mentioned, and the caustic soda in the following manner:

$$(CO_3)_2\ Ca\ H_2 + 2\ Na\ OH = CO_3\ Na_2 + 2\ H_2O + CO_3\ Ca.$$

The caustic soda reacts on the calcium bicarbonate as would calcium oxide, but much more rapidly. New products will then be formed, namely, sodium carbonate and bicarbonate, which will be returned to the boiler.

If the quantity of the blowdown is calculated in such a manner that it brings down the quantity of soda necessary in a given time for the purification of the water entering the boiler in the same time, it will be seen that it will not be necessary to add any carbonate of soda for purification of the temporary hardness of the water. A closed circuit will be formed containing a certain quantity of soda, which will never be exceeded. The soda is never concentrated in the boiler, because no fresh soda is introduced. The concentration in the boiler depends on the proportion of blowdown in relation to the feed water. The less the quantity of blowdown the greater will the concentration become, so that the same quantity of salt will be contained in a smaller volume.

It is therefore of the greatest importance to combine purification by soda with the continuous blowdown. This allows of more economical use of the chemical reagents necessary for freeing the water from the bicarbonates of the alkaline earths. Consequently, owing to the circulation of the blowdown through the purifier, there is a blowing through the deposit favorable to drawing-off and purification at high temperature by using the heat that would be thrown away in the drain under ordinary methods of blowing off. The concentration of the soda in the boiler is limited, and neither deposit nor incrustation can be produced. The consumption of soda is reduced to that necessary for the

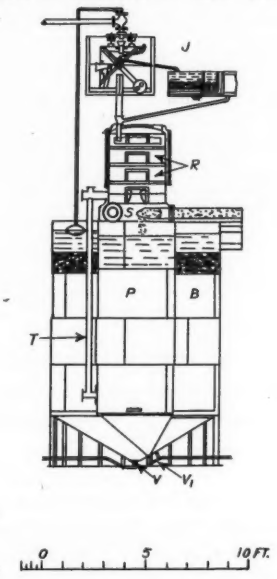


FIG. 3. KESTNER BLOWDOWN APPARATUS

decomposition of non-carbonates. Kestner has devised the following apparatus using a blowdown on the preceding principle, Fig. 3.

This apparatus consists of a steam separator S into which the blowdown enters in the form of a mixture of steam and water. The liquid from the blowdown falls into a central reservoir P, in which it gives up its heat to the water surrounding it in the annular chamber B, into which it is decanted.

The steam from the blowdown rises in the reheater R, in which it reheats the feed water, which loses a part of its bicarbonate owing to the rise of temperature. The water thus heated falls through the tube T and mixes with the blowdown as it leaves the central chamber, and then rises in the annular chamber B, in which precipitation and settlement take place. Reheated by admixture with the blowdown, as well as by exchange of heat with the central vessel, the purified water passes through the filter and enters the boiler. The soda is distributed in the apparatus by means of a water meter J, which admits it in proportion to the new water (make-up feed). The valves V and V_1 allow the mud to be separated.

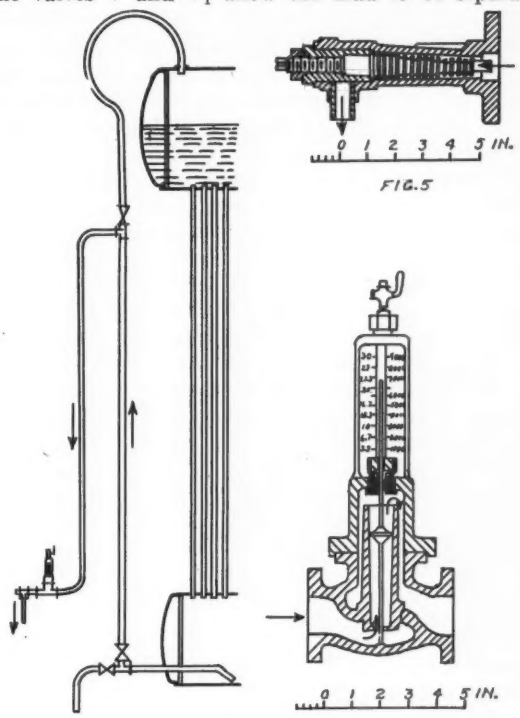


FIG. 4. CONTINUOUS BLOWDOWN PIPING
FIG. 5. REGULATING BLOWDOWN VALVE
FIG. 6. FLOW INDICATOR FOR BLOWDOWN

This apparatus enables the thermal and chemical properties of the blowdown to be utilized, or, in other words, heat and chemicals are saved.

Position of the Blowdown

It is necessary to arrange the blowdown at the lowest possible level on the boiler without risk of emptying it. A simple arrangement is recommended by which, when the water of boiler falls below a certain level, the siphon action of the blowoff is destroyed. At this moment steam leaves by the inlet and calls attention by sounding a whistle. In any case it is impossible to empty the boiler by the continuous blowdown, Fig. 4.

On the pipe of the continuous blowdown and the outlet from the boiler, a reducing valve is placed, which reduces the pressure of the blowdown from that of the boiler to a pressure of between 15 and 30 lb. per sq. in. before it enters the purifier. In order to allow of the amount of the blowdown being regular, a meter is placed at the outlet of the boiler and is fitted with a regulating valve, Figs. 5 and 6.

Proportions of the Blowdown

The proportions of the blowdown are calculated according to the temperature to be maintained in the

purifier. It is always desirable that the temperature at which purification is effected should not be less than 70 deg. C. (158 deg. F.). According to the working pressure of the boiler, various rates of blowdown may be used, and these can be obtained by the curves, Fig. 7.

The temperature at which the water leaves the purifier, although very nearly 100 deg. C. (212 deg. F.), allows of the use of an economizer, as has been shown by recent researches in France.

Central Station Using Distilled Water

It has just been shown how the system of continuous blowdown can be applied to a boiler using purified water. A case offering still greater interest is that of central station using distilled water.

Distilled water of industrial appliances differs greatly from the distilled water of the laboratory. In these appliances, it is necessary to blow down the boilers as a concentration of the boiler contents rises, due to the entry of salts through accidental leakages of impure water in the condensating plant; thus the water that has been distilled contains numerous soluble salts, present in smaller proportions than in purified water, but by no means negligible. The following relationship is found to exist between the water in the boiler and the water of distillation:

Foreign substances in parts per 1,000,000	Untreated Water	Distilled Water	Proportion of remaining Salts
Total solids at 110 deg. C., 230 deg. F.	5,427	26.4	1/205
Total solids at 400 deg. C., 752 deg. F.	4,414	8.4	1/525
Organic substances	1,013	18.4	1/55
Silica, SiO_2	243	1	1/243
Oxides of iron and alumina	200	3.2	1/62
Lime, CaO	73	2	1/36
Magnesia, MgO	42.4	1	1/42
Chlorine	2,583.8	Traces	0
Sulphates, SO_3	407	0	0
Hardness	24	0.54	1/44

In boilers using distilled water, this water in time becomes a fairly concentrated liquid. Organic matter—oils and grease particularly—is present in considerable quantity, and only a small quantity is necessary to produce priming. It is, therefore, necessary to avoid this concentration, and continuous blowing-down is consequently applicable in this case also.

Boilers working with distilled water therefore require to be blown down occasionally, but, owing to the small amount of salt that they contain, it is useless to remove a large quantity of liquid. These boilers are consequently blown down to the extent of 1 or 2 per cent only, which means that the quantity of saline solution is replaced in the boiler by distilled water. By this method the increase in the quantity of dissolved matter is necessarily limited. It could not, for example, exceed 50 times the concentration of the distilled water taken from the condenser, in the case of a boiler blown down to the extent of 2 per cent. In the case quoted above, this corresponds to a dry residue of 1.3 grm. per litre, 76 grains per gal., which is certainly not negligible. The water blown down is of no special interest so far as its chemical composition is concerned; but it is hot water which enters the distilling apparatus without loss of its heat.

Even when an evaporator is used, the continuous blowing-down method can be adopted. A certain amount of saline or impure water can be drawn from the boilers and passed into the evaporator; this latter returns it to the boiler after it has been freed of the greater portion of its salts. It will be seen later how the simultaneous use of continuous blowing-down, in conjunction with degassing, allows of the establishment of a complete closed water circuit in a central station using distilled water.

To avoid the slowing of the oxidizing process by the rust deposit on the iron, Kestner has designed an apparatus based on the following: If an apparatus for removing gases by means of iron is left with the iron rusty, it is found that after a day of rest, the rust, which was red, has become an oxide of a greenish-black color. This transformation is due to the reduction of the ferric hydrate under the influence of the iron; a saline hydrate of the oxide and a ferrous oxide is obtained. The following is the reaction:

$$2\ Fe\ (OH)_3 + Fe + 2\ H_2O = Fe_3\ (OH)_8 + 2\ H.$$
$$2\ Fe\ (OH)_3 + Fe = 3\ Fe\ (OH)_2.$$

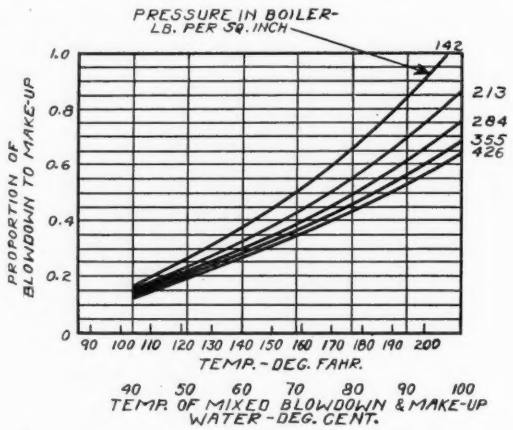


FIG. 7. PROPORTION OF BLOWDOWN TO MAKEUP WITH VARYING TEMPERATURES AND PRESSURES

This reaction takes place in the middle of the reducing agent, that is, in the presence of iron and in the absence of oxygen. The saline oxy-hydrate formed is easily removed from the iron by washing, and moreover it is capable of further absorbing oxygen in becoming ferric-hydrate. In order that the apparatus for removing the gases should retain its working speed, it is necessary that it should be put alternately in and out of circuit, the two appliances in work retaining the power of the iron for absorption until the latter has been completely oxidized. The Kestner apparatus, Fig. 8, is based on this principle, and consists of a column of turnings of sufficient quantity for half only to be in action, and to allow that the water shall have lost these gases on arriving at half the height. The second portion of the iron being in contact with this deoxidizing agent gives rise to rapid reduction, its rust changing to the condition of a suboxide. At the end of the day, the direction of flow is reversed. The water then passes over the iron, which has been a suboxide, which is then

changed to a peroxide, and arrives free from gases on the surface (rusted the day before) which in turn is reduced. Thus, each half of the apparatus works alternately by inversion of the direction of circulation of the water, and the removal of the gases becomes continuous and absolutely regular.

The Kestner apparatus consists of a column of iron turnings placed between two filters with an intake and outlet for the water at each end of the apparatus, in such manner that the direction of flow of the water can be inverted at regular intervals. The consumption of turnings and the speed of the absorption of oxygen are approximately regular, and the arrangement for allowing steam to be admitted at the base of the apparatus allows it to be cleaned by blowing steam through and removing any rust which may become detached from the iron on which it was produced.

Consumption of iron turnings in the apparatus for removing gases is small; according to the percentage of oxygen contained in the water, it varies from one to three grammes per cubic meter (per ton) of water which reduces the cost of the removal of gases to a negligible figure. The iron consumed in the gas-removing apparatus corresponds to the same weight of boiler-plate which has been saved from destruction, and the difference in first cost between the two materials destroyed forms a great saving.

Whatever may be the method employed for removing the gases, it involves a circuit of water closed from

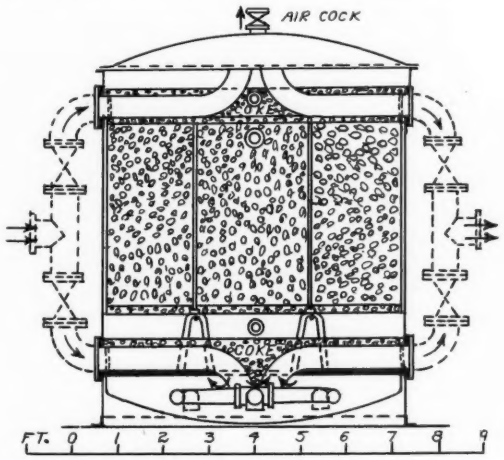


FIG. 8. ARRANGEMENT OF KESTNER DEGASSER

atmospheric contact if it is to give a large output. The water which has been freed from gas can become saturated rapidly by air. It is, therefore, advisable that the tanks in which the water may be retained should be as well enclosed as possible, and that on the whole of the pipe system there should be a small positive pressure. A head of a few inches of water is sufficient to prevent the entry of air which might occur through bad joints or accidental circumstances. In such a pipe system the only place at which the entry of air may be possible is the condenser in which the vacuum is produced. The tightness of the condenser should, therefore, be carefully tested. Moreover, to avoid the effect due to any air entering by accident, which may always occur, it is essential that the water should pass through the gas remover immediately before entering the boiler, even though this water should result from condensation, and though it may only contain a small quantity of oxygen. Iron turnings are only consumed according to the percentage of oxygen in the water, and water free from gas does not change this; consequently, it does not necessitate expense by being passed through the degasser. The degasser so placed protects the boiler and the economizer from any attack by the gases, and acts as a doorkeeper to prevent the entrance of anything undesirable.

Study of continuous blowing down, on the one hand, and that of degassing on the other hand, have led to the conception of a complete circulation system for a central station using distilled water. The main guiding principles of this idea are as follows:

Ability to use any one boiler as a distilling appara-

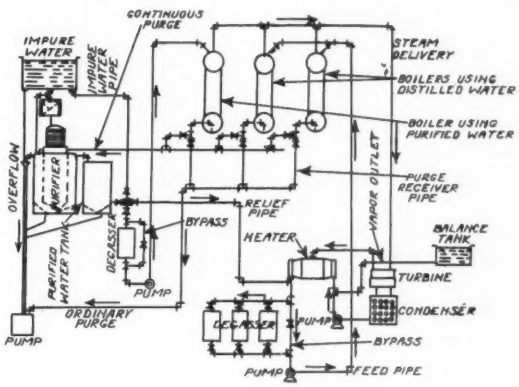


FIG. 9. DIAGRAM OF DEGASSING, PURIFYING AND DISTILLING PLANT USING PURIFIED AND DISTILLED WATER, ONE BOILER SERVING AS EVAPORATOR

tus, and to feed the other boilers with the water distilled in this boiler.

Blowing down of a large quantity of water from the boiler that is performing the function of distilling; the blowing off of only a small quantity of water from the boilers using distilled water, and the conveying into the distilling boiler of the water so blown down.

Protecting of the condensed water from all contact with the air by means of a closed circuit; the degassing of the condensed water before its passage through the economizers and the boilers.

From the moment at which the water is degassed the keeping of it enclosed so that no entry of air is possible.

Degassing of the water to be purified before it passes into the distilling apparatus.

There should be no point on the circuit of the purified water in common with any on the circuit of the distilled water.

The only appliances that may be common to the boilers are the blowoff manifolds and the steam mains.

It will be seen that the scheme of this system of water circulation purification and degassing rests on a broad basis, and that the distilling apparatus may equally well be an evaporator or a boiler. Each has its respective advantages.

For a water circulation, purifying and degassing plant the following system is proposed by Kestner, Fig. 9.

One of the boilers is to evaporate the purified water coming from the purified. It will supply steam that

will go with that generated by the other two boilers to the steam main. The steam will pass through the turbines, it will be condensed and it will re-enter the boilers as distilled water after it has passed through the degassing apparatus.

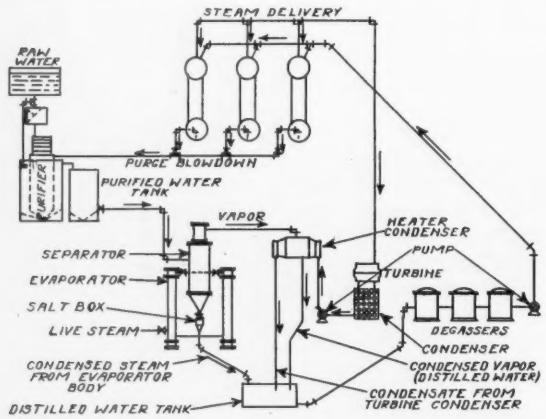


FIG. 10. DIAGRAM OF DEGASSING, PURIFYING AND DISTILLING PLANT USING PURIFIED AND DISTILLED WATER WHICH HAS PASSED THROUGH EVAPORATOR

All the boilers are to be blown down, the boilers using distilled water to the extent of, say, 2½ per cent, and that performing the distillation of the water to the amount of, say, 10 per cent, and all of these amounts that have been blown down are to pass collectively through the purifier in which they will be subjected to the same treatment as the ordinary "make-up" feed water, and the impurity is to be measured by the testing apparatus. The purified water is to be returned to the particular boiler performing the distilling, after it has passed through a special degassing appliance.

The boiler containing the water that is to be purified will thus furnish the supply to the boilers working with distilled water in the form of steam; there will be no common portion between the circuit of the purified water and that of the distilled water. It will merely be necessary to provide an overflow reservoir to enable any excess of purified water to be re-introduced into the circuit if such excess should be produced.

All the boilers can be fed either with purified water or with distilled water, which enables any desired boiler to be used for the work of distilling.

Such a circuit will ensure that a central station will have the best possible thermal balance sheet, and moreover a longer life for the boilers, which the process protects from formation of scale and corrosion.

It is obvious that a similar scheme can be arranged for the distillation by means of an evaporator, which in certain circumstances offers advantages. Such an arrangement is illustrated in Fig. 10.

The Dittlinger Mills

DESCRIPTION OF DIESEL ENGINE PLANT IN FLOUR MILL AT NEW BRAUNFELS, TEXAS. BY JOHN PIERCE

CLIMBING DOWN from the cross country bus, I found myself in a beautiful little city of several thousand people, 90 per cent of whom were German or of German descent; and the town is typically German in its beauty and its cleanliness. The Dittlinger Mills was my destination and Fig. 1 is what I found, and I was surprised to find such a large building in such a small town.

Locating the power plant I found myself in one of the best equipped little engine rooms in the South.

This room is 100 ft. long by 40 ft. wide with 30 ft. ceiling, and one entire side of it is glass. Overhead it has an I beam running along each side of the wall, and a traveling crane is mounted on these beams, to which is attached a 4-T. chain blocks, and which covers, owing to the double ways of the tracks, every inch of the engine room. The small photo of the Busch-Sulzer engine, Fig. 2, shows the tracks and the blocks, as well as the Busch-Sulzer unit together with its compressor, manifold, and water lines. Since this picture was taken a triplex single acting pump has been installed in that end of the room and directly under the point where the blocks now hang in the photo.

This engine is a 225-hp. type "A" with 16 by 24-in. cylinders, and has been running constantly for the 10 yr. since its installation. Fred Schreyer—"Fritz"—is the chief engineer and has been with the company ever since the engine was first set up, having helped the factory man install it, and naturally he knows it "like a book." He has broken three cylinder heads since the engine was installed, but has thrown but one of them away, having had two of them welded and has them now on the engine. The engine has never been rebored since installed, and does not shows any signs of decreased power, nor leakage through the cylinder. Rings are changed once a year in this engine, and an entire new set put in, though "Fritz" says that some of the old ones could be used again in case of necessity. A complete set of three heads and cylinders is kept in stock, however, so that the mill will not be delayed any length of time should anything happen to any one, or all of them.

This engine broke its crank shaft about 3 yr. after it was installed, but was stopped before any great damage was done, though the main bearings were torn out, and had to be replaced. The shaft did not let go entirely, but gave a little warning so that she was shut down before the entire engine was destroyed. The shaft had been "jumping" for several days prior to the accident, but the management did not want to waste any time just then, and so ordered her kept going, with a much greater loss of time than they would have had if they had only stopped long enough to level the bearing. This engine is direct connected to the main shaft of the mill, but with a clutch, so that the mill may be thrown off while starting the engine, or while working on it in case the other engine is to be kept working.

The other engine is a Fulton type "F3F" with cylinders 15 by 20 and is rated at 200 hp. This engine is belted to the main shaft, also, through a clutch so that it can be thrown in or out when such action becomes necessary. The accompanying photo, Fig. 3, shows the

old lady in one of her idle moments; she is a little beauty, and has been running for a little more than 7 yr., giving not one moment's trouble in all that time, and doing her share of the work without a single complaint. A complete cylinder, with head and fittings, is kept in stock for her, but has never yet been used. As with the other unit, this one also has her rings changed once a year. The needles that came with her are still in service, while the needles on the Busch-Sulzer have been changed about every 6 mo. The Busch-Sulzer needles are made of bronze, owing to the fact that the steel needles from the shops are too hard and break the points off quite frequently. Both engines are fitted with overflow funnels in plain sight, and each overflow on each engine has a large 5-in. thermometer in plain sight of the operator, so that he may know at all times just what the temperature of the water is. The overflow is carried at 110 deg., less than that seeming to hurt the efficiency of the engine somewhat, and more than that heating her too much. It seems that "Fritz" has done quite a little experimenting with the temperatures of his overflows, for he speaks with authority on the subject.

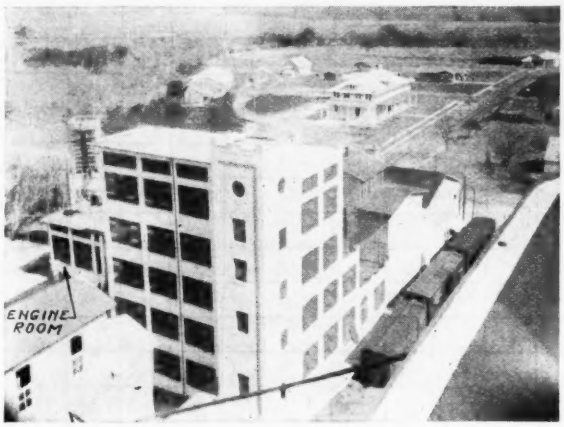


FIG. 1. BIRDSEYE VIEW OF DITTLINGER MILLS

Asking both "Fritz" and the manager, I. A. Ogden, which engine they liked best, and which seemed to have proved the most efficient, I was told that it was a good deal like the man who loved a pair of twins, and when he did finally make up his mind that Mary was the one he loved best he would be sure to find some new thing about Jane that caused him to hesitate in his choice, and so went through life loving both, but never certain which one was his exact choice. Neither of these two men has a single word of condemnation to say against either engine, but at the same time neither can say enough for either of the two engines—in fact, they are in love with the two of them.

They have no indicators, nor other means of testing these engines and therefore cannot say as to just what they are really doing, though they claim that both engines are pulling as well now as when they were first installed, and feel, therefore, that they are holding up to their guaranteed points of efficiency. All that they do know is that it is costing them the same for fuel per horsepower as it did when they were first purchased (allowing for the change in prices, of course, in fuel). It costs, with the so-called "gas oil" at 32—36 gravity, 4½ cents per gallon laid down in their tanks at New Braunfels, slightly more than 1 cent per barrel of flour for fuel. I have had no experience with mills and therefore do not know how one could figure the horsepower necessary to produce a barrel of flour, and so arrive at the fuel consumption of the engines, but beyond doubt

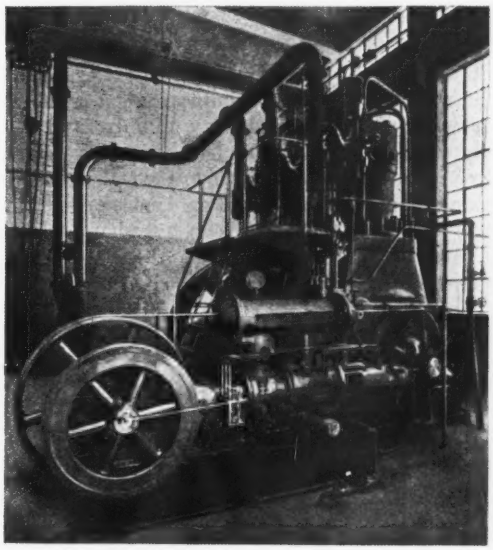


FIG. 2. VIEW OF ENGINE ROOM SHOWING COMPRESSOR AND BUSCH-SULZER DIESEL ENGINE

many of the engineers who read Power Plant Engineering will know how it is done.

Figure 4 shows a copy of the daily log kept at the engine room, showing the amount of oil and the kind used on each engine, together with the water for the crank-case and the amounts used. Floor men are required to work 12 hr. a day, while the chief, "Old

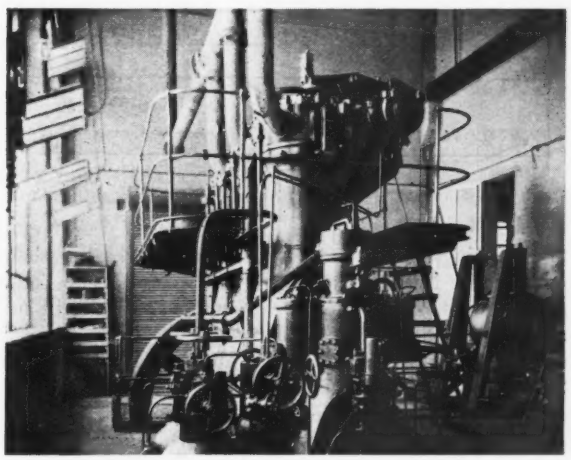


FIG. 3. FULTON ENGINE IN DITTLINGER MILLS ENGINE ROOM

Fritz," works all the time. Yet, judging from the smooth running of his engines and the very little valve grinding that he has to do, I imagine that even "Fritz" does not raise a sweat so very often.

While I have listened to a great many smooth run-

ning engines of this kind, I have yet to hear one that runs as quietly as are running these two engines in this plant. In all Busch-Sulzer type "A" engines the fuel cam is round with the exception of the fuel nose which gives a quick rise out of the true circle—every Diesel man will know what I mean—and as the cam passes under the roller it causes a quick opening and a quick closing, yet being so short it passes under the roller and away from it so fast that the roll does not follow it down but leaves its contour and strikes the cam at the point about where the nose ends, not only battering the cam out of round at this point, but causing considerable of a jar which can be heard very plainly, and felt distinctly if one places his hand on the engine anywhere.

One sometimes thinks that the whole engine is knocking on account of it, and gets more or less worried, but "Fritz" has "fixed" this in fine shape. He found causes no trouble at all. In the engine room is located a small but complete double panel switchboard and the voltage is controlled by a Tirrill regulator. Oil is pumped into engine tanks by a slow moving belt attached to the hand pump, so that the engineer does not have to bother with this except in case the oil is a little low before starting.

In the past it was found that the heads scaled up badly, and had to be cleaned quite often; but as the water was taken directly from the beautiful river which flows by the engine room door, and wasted directly back again, they have overcome the scale problem by building a large tank and placing it on a steel tower 100 ft. in the air, from which the water flows to the jackets and wastes, or overflows, into a large tank underground, from where it is again pumped to the tank on the tower. The only waste is that which goes over the

	BUSCH-SULZER ENGINE					FULTON ENGINE					BUSCH-SULZER ENGINE					FULTON ENGINE			
DAY RUN	FUEL OIL IN GAL.	LUBRICATING OIL IN GALLONS	CRANK CASE WATER IN GAL.	CYLINDER OIL IN GALLONS AIR COMP.	REMARKS	FUEL OIL	URSA OIL	RENOWN OIL	CUT COMPOS. OIL	NIGHT RUN	FUEL OIL IN GAL.	LUBRICATING OIL IN GALLONS	CRANK CASE WATER IN GAL.	CYLINDER OIL IN GALLONS AIR COMP.	REMARKS	FUEL OIL	URSA OIL	RENOWN OIL	CUT COMPOS. OIL
A.M. 6	8½		3			6				P.M. 6	8		3			5			
7	9		3			6				7	8½		3			5½			
8	9		4½			6½				8	9		4½			6			
9	11½		4½			8				9	9	0	3			6			
10	13½		3			10				10	9		3			6			
11	13½		3			10½				11	9		3			6			
12	13		3			9				12	9		4½			6			
P.M. 1	11	¼	4½			7½				A.M. 1	9	¼	3			6			
2	13		3			9				2	9		3			6			
3	13		3			9				3	9		4½			6			
4	11		6			7½				4	9½		3			6			
5	10	1	3	½		7	2	¾	½	5	9½	1	3	¼		6	2	¼	¼
TOTAL										TOTAL									

DAY ENGINEER NIGHT ENGINEER

RECORD OF H. DITTLINGER ROLLER MILLS CO., NEW BRAUNFELS, TEXAS ENTERED CHECKED DATE _____ 192

FIG. 4. COPY OF DAILY ENGINE ROOM LOG

that he could not change the tension of the factory made springs to any extent, and so has devised a scheme of his own for the fuel valve that causes it to follow over the nose and down its contour as it should, in such a way that it can neither be heard nor felt. Figure 5 is a rough sketch of the entire attachment; any Busch-Sulzer man will know how it is applied, and I would surely advise any of them that have not got it to make one and put it on at once, for it is truly a great benefit to the engine as well as to one's peace of mind.

In addition to the regular flour mill at this place they have rye and corn mills, which also help to weigh down the two units just described, and each engine pulls a General Electric alternator of 144 kw. capacity which generates current for the mill and office lights and for the motors which handle the elevators.

Main drive from the Fulton engine is rope, and needles, and that is sent back into the river. As it is now handled, the only new water taken into the system is enough to make up the loss just mentioned, and that is treated so that there is now no tendency to scale, and the heads remain perfectly free and clean.

Another thing that caused great trouble was that the water that passed over the needles was sent into the exhaust chambers, as is done with all the old type Busch-Sulzer engines, and it was found that the manifold corroded and rotted out, and at the bends would burn badly. After changing manifolds a time or two, they decided that they would not use the water in the manifold but would turn it directly into the river, and this was found to stop the rotting and corroding of it, but the exhaust chamber and riser pipe sections of the manifold heated too much without the use of water, so they secured a new set of risers from the factory that had

water cooled jackets, and by running the waste from the needles through this they not only hold down the heat but have stopped all the troubles coming from that source.

Oil storage tank is a large steel cylinder set on the surface and contains 15,000 gal. of oil. It is now being considered as possible to get a lower gravity oil and mix with the oil being used at present and getting a better grade than either of the two oils alone, and with this in mind they are clearing a place for the installation of a second storage tank with the same capacity as the one now in service.

Each man is equipped with a steel locker for his personal effects, and a fine shower bath is just outside the engine room door. The engines have a complete equipment of wrenches for each engine and all are housed neatly on wrench boards located near their respective engines. The engine room is warm and as clean as a parlor, and everything is found in its appointed place. Fuel valve on Busch-Sulzer is kept at 3¼-in. lead on flywheel as less than this lowers pulling capacity of engine while more than this and she won't turn over in starting and getting up to speed. This lead has been carefully worked out by many days of experimenting, and found to be the most satisfactory position.

Going back, for a moment, to the use of the attachment which "Fritz" has for aiding the fuel roller to follow the cam, I wish to say that with the turnbuckle one can adjust the tension on the spring to such a nicety, that it is really a pleasure to listen to his engine —I am back-tracking to the attachment simply because I have failed to tell what particular part it played, and while a Busch-Sulzer man would know, it is possible that others who read this might not.

All moving parts in the engine room are carefully screened so that it is impossible to get caught in the belting or the spokes of a wheel, or in fact any place else, and is arranged exactly like the laws of Germany require for the protection of employes in and around running belts, motors, etc. Every bit of the guards are well built and solid, and though one fell heavily against it there would be no danger of its giving way and allowing him to get mixed up with any of the moving parts.

"Fritz" asked me what I was wanting to find out about his plant for, and I told him that I was going to tell the world that he had a fine plant, and one of the best running outfits that I had ever seen, and he said,

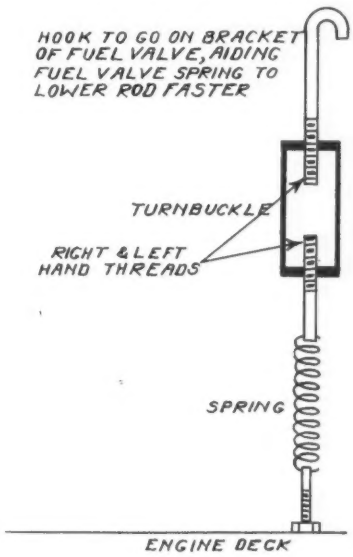

HOOK TO GO ON BRACKET OF FUEL VALVE, AIDING FUEL VALVE SPRING TO LOWER ROD FASTER
TURNBUCKLE
RIGHT & LEFT HAND THREADS
SPRING
ENGINE DECK

FIG. 5. ATTACHMENT WHICH CAUSES ROLLER TO FOLLOW CAM CLOSELY

"Vell just tell dem that when dey comes to this end of de world to come right in undt see old Fritz, undt his leetle engines."

So, in the name of "Fritz," I extend to you all his invitation.

Oil Engine Hints

WHY THEY STOP SOMETIMES AND WHAT TO DO FOR THEM. BY C. A. WENDELL*

"FUNNY what some folks will do to an engine," said the trouble shooter as we were sliding along through a wet April day. "Now, I'm just in from a trip of 150 miles which I made to knock the head out of a barrel. Didn't need to go that far to find a barrel either; but it had to be that special barrel."

Naturally I wanted to know more about it, and said, "I thought you were a gas engine man, not a cooper."

"Well, in shooting engine trouble, one has to be a little of everything, but mostly Sherlock Holmes stunts are what is needed. You have to be able to guess what a man is likely to do when his horse sense is turned out to grass and every man will do something different, just for variety, I guess.

"I didn't start after a barrel. In fact, it took me some time to find that I wanted it. You see, this man had remodeled his plant and then wrote us one of those 'Hurry, the baby is dying' letters that his engine would run only for a couple of explosions and then quit cold. He thought it didn't like the air in the southeast corner of the basement or something; or the piston rings had frozen on account of the cold weather, it being the coldest March for 43.5 yr. or thereabout.

"So on the basis of time and expenses, I went down there. And she acted just as he said. I took down the fuel line, but it was clear; air supply was O. K.; she had a good spark and the governor worked freely. What to do next?

"I went outside to have a look at the exhaust, but couldn't see any pipe, so, inquisitive like, I asked the the owner where he was storing up his exhaust gas, and why? And to my surprise he showed me a barrel, sunk in the ground, with the head in and a ¾-in. hole for 'ventilation.'

"It took one minute to smash in that barrel head, one more to start the engine—and she kept right on going. But I gave that owner his money's worth in advice and explanation of how to treat an engine, why she runs, and what she needs to keep her going."

*From Oil Field Engineering.

"But are all the troubles as 'ornery' as that?" I asked.

"No. Some are real troubles, and some are catastrophes," he said. "There was a man running an elevator in a small town who was found dead beside his engine. When I got there I found that for some reason he had taken off the caps that were on the crank shaft to cover the flywheel keys. Then, apparently, he leaned over the engine while it was running to oil the bearing and one of the keys caught his overalls at the stomach and threw him into the machinery."

"Too bad, people will take a chance," I commented. "Don't they realize it is dangerous?"

"Oh, yes. They just get careless or are in a hurry and try to save a few seconds; then they spend a few weeks thinking it over if they even have a chance to think. But sometimes it isn't the fault of the engineer at all.

"There was one job had several of us guessing. It was an oil engine with the fuel tank buried 20 ft. away and 3 ft. below carbureter level. She would run, sometimes half an hour, sometimes half a day; then she would give a couple of dying gasps and quit. We went over the carbureter, the fuel pump, ignition governor and the fuel line valves. Everything was O. K. and she had run perfectly up to a week before.

"It didn't seem possible that the underground line could clog as there was a strainer on the end, but we dug her up just for luck. Nothing there, and air blew through into the tank freely.

"But," my partner said, "there's no trouble anywhere else, so let's have a look at the tank. Anyway, I'm kind of getting to like this place and digging is good for the appetite." So we dug up the tank, hauled her out and rolled her over—and we found about a dozen marbles which some experimenting kid had dropped into the tank. The suction from the fuel pump would gradually work them up around the end of the suction pipe strainer and choke off the oil. When we put her back, freed of marbles, she ran fine as ever.

"I suppose you can spot usual difficulties by wireless now," I ventured. "Never tried just that," he answered, "but we treat 'em by telephone sometimes. One hot day a man called up from 200 mi. away and said his engine had an awful knock. They were afraid to run it, but it had to run, and I must come at once or sooner. I wasn't exactly aching for a 400-mi. trip on a hot train, so I asked him to give exact symptoms as to how the knock started, where it was, how it sounded and the like. Then I gave him the prescription—to put some oil and grease on the governor weight pins, the collar and the detent lever. It was a 'hit and miss' governor in which the cam must hit the roller so as to release the detent lever when the speed falls off. If these parts get dry, they can make a deuce of a noise, but a little oil and grease stops the whole riot. And all it cost him was a few minutes' extra telephone toll instead of my time and car fare. Yes, he did buy a stamp, too, to thank me for helping him out."

"It must take ingenuity to keep an engine going in emergencies," I suggested.

"Yes, we have to do queer things sometimes," he agreed. "Most of them wouldn't qualify as good engineering practice, but they serve to get the result. Only last week I went to see why an engine had 'lost its power,' and I found the explosion was mostly leaking past the piston into the crank case. The cylinders and rings were badly worn and the real remedy was reboring the cylinders, a new set of pistons and rings. The owner couldn't wait for all that, not just then anyway, so I took out the pistons, removed the rings and in each groove put a piece of asbestos rope soaked in oil and graphite. The rings were put in on top of these and with an oil bath squeezed into the cylinders. It ran all right, and the engine gave full power, but, of course, it was only a temporary remedy and she would gradually lose power again."

"What do you find most common causes for troubles?" I asked.

"Well, they're all different," he replied. "The old rule, 'Spark, oil, fuel, water, then she'll run just as she oughter,' is a good one when hunting trouble; but I have a set of stock cautions that I usually donate to the engineer when I have fixed up his troubles. Some are warnings, some are just trouble kinks.

"The governor must work freely. Keep it lubricated. And don't try tightening the governor springs to get more speed. You may get a little more power, but you will use a lot more fuel. Your engine was designed and set to give maximum of power with minimum of fuel.

"Have the bearings tight enough to prevent pounding, but loose enough not to heat. Watch 'em and oil 'em.

"If you have jerky running and the carbureter is set right, empty the fuel tank. You may have water in the bottom. If a check valve is sticking, put in a new one. Saves time and patience.

"When your igniter points get carbonized, double a sheet of fine emery cloth, insert between the points, tighten them up on it and pull the cloth out. Repeat, if necessary. It cleans them and leaves them even.

"If you get a small crack in a water jacket, put a little sal-ammoniac in the water. Bring it to the boiling point and let it stand over night. This will usually rust the leak shut, but it may not. And anyway, drain the jacket afterwards to get all the sal-ammoniac out."

"Thanks for the hints," I said. "They'll come handy. And thanks for making a dull ride profitable."

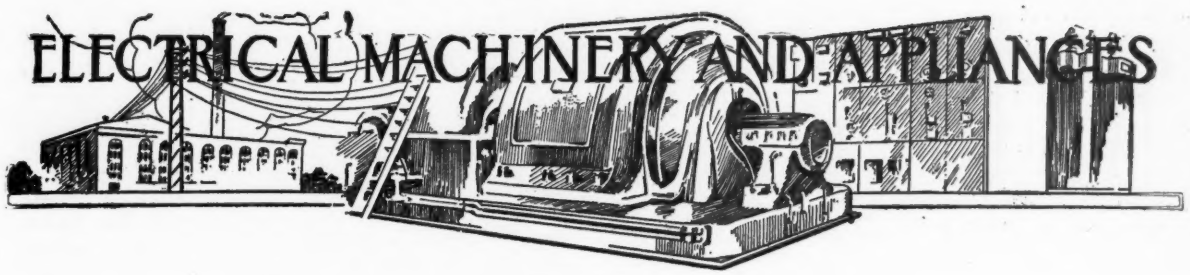
"The pleasure is mine," he replied. "I like shooting trouble, but I'd rather prevent it than shoot it."

Oil Burning Steamships

THE many advantages of oil as fuel for steamships are well known, but the disadvantages which would arise from this method were not foreseen or they were neglected, if we are to believe a recent report from Washington.

We are informed that not only have many bathing beaches been almost "put out of business," fish and oysters dying by the thousands due to the water being polluted, but a great fire hazard now exists at many docks, all of this caused by the oil drippings from oil burning steamers, and it is expected that President Harding will be called on to take some action for remedial measures.

Surely there is a way to take care of the "seepage." There must be or it will be back to coal.



Balancer Set for Battery Charging

CONNECTIONS, CHARACTERISTICS, AND CALCULATION OF CURRENT, VOLTAGE AND POWER REQUIREMENTS. BY H. M. PHILLIPS

THE "BALANCER" is usually considered to be a device for converting a two-wire direct current system into a three-wire system by supplying current to a third "neutral" wire and maintaining an equality of voltage between it and the two wires of the main current. It may, however, be so designed as to maintain any desired voltage between the neutral and one of the main wires and this potential may be made adjustable by means of a field rheostat, which renders it available as a battery charger.

Connections of a balancer, as used on the ordinary lighting system, are illustrated in Fig. 1. As illustrated, the fields of the two machines are wound for 115 v. and connected to a small split rheostat so that a movement of the rheostat weakens one field while strengthening the other. The two armatures are wound for 115 v. each, are coupled together and are connected directly across the line. No compound winding is shown in the illustration, although quite frequently used in practice. When used, it is the usual custom to connect the series winding of one machine in series with the armature of the other, the object being to maintain the closest possible balance of voltage with an unbalanced load on the system. Compound winding is not advisable when used for battery charging.

Shunt fields may be wound for 230 v. and connected across the main line, either with a split rheostat or with independent rheostats; if there is to be a considerable difference of potential between the two sides, as will probably be the case in battery charging, the connection across the main line is preferable as it allows the fields of both machines to be wound for the same voltage. Weakening the field of one machine will increase the speed of the set, with a corresponding increase in voltage of the other machine; as the total voltage of the two machines must equal that of the line, that of the first machine is lowered as much as the second is increased.

If the second machine is not already on full field, increasing its field current will bring the speed back to normal and effect a further decrease in the voltage of the first; the use of the split rheostat, which decreases the strength of one field while increasing that of the other, will prevent wide variation in the speed of the set. With both armatures wound for 230 v. the field of one machine could be reduced to zero while full field was maintained on the other, which would allow a regulation of from zero to 230 v. between the neutral and either of the main wires. Although this combination would be extremely flexible, it would be unnecessarily expensive for ordinary purposes.

In considering the problem of battery charging, it will be assumed that the available main line voltage is

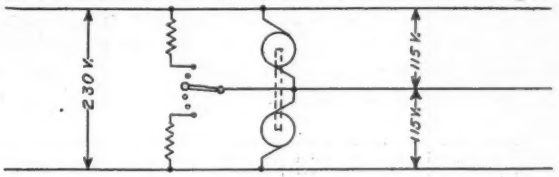


FIG. 1

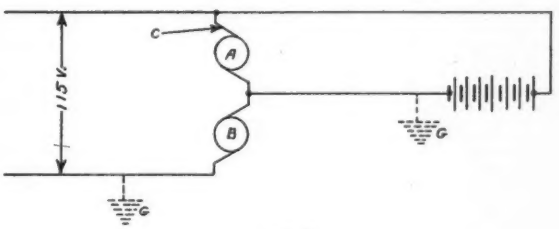


FIG. 2

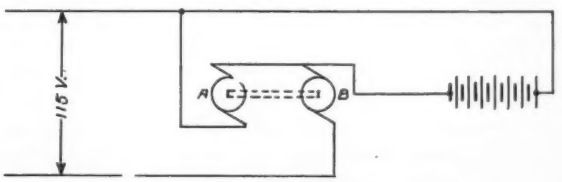


FIG. 3

FIG. 1. CONNECTIONS OF BALANCER FOR ORDINARY LIGHTING SYSTEMS

FIG. 2. DIAGRAM OF CONNECTIONS FOR BALANCER SET CHARGING A STORAGE BATTERY

FIG. 3. DIAGRAM OF CONNECTIONS SIMILAR TO FIG. 2 BUT ARRANGED TO BRING OUT BOOSTER FEATURE

115, that charging begins with 100 amp. at 2 v. per cell, is maintained at 100 amp. and 2.25 v. through the major part of the charge, and ends at 50 amp. and 2.5 v. Reference will be made to the simplified diagram shown in Fig. 2. If the battery consists of 24 cells, armature A will operate on 48 v. at the beginning and 60 v. at the end of the charge; while armature B will operate at 115 — 48 = 67 v. at the beginning and 55 v. at the end.

The maximum power delivered to the battery will be $24 \times 2.25 \times 100 = 5400$ w. and, assuming for the

moment that the efficiency of the booster set is 100 per cent, the current in the main line will be 5400 ÷ 115 = 47.0 amp. As all of this current must pass through armature B (and through the battery), it will act as a motor, driving armature A as a generator and enabling A to generate the balance of the current (100 — 47 = 53 amp.) required for the battery. The voltage at the motor terminals is now 115 —(24 × 2.25) = 61 and the power input 61 × 47 = 2867 w.; on the assumption of 100 per cent efficiency, this would also be the output of the generator, at 54 v., its amperage would be 2867 ÷ 54 = 53, the amount required to make up the 100 amp. for the battery. Allowing an efficiency of 82 per cent for both motor and generator, the over-all efficiency of the set would be 82 × 82 = 67 per cent, giving a loss of 33 per cent, or 2867 × 0.33 = 946 w., which must also be supplied by the line and will require an additional current of 946 ÷ 115 = 8.2 amp., making a total of 55.2 amp. which must pass through the motor armature at the same voltage as before and increases its input to 61 × 55.2 = 3367 w. This new value in turn increases the losses to 3367 × 0.33 = 1111 or 1111 ÷ 115 = 9.7 amp., giving a total of 56.7 amp. and a new motor input of 61 × 56.7 = 3459 w., which is so close to the previous approximation

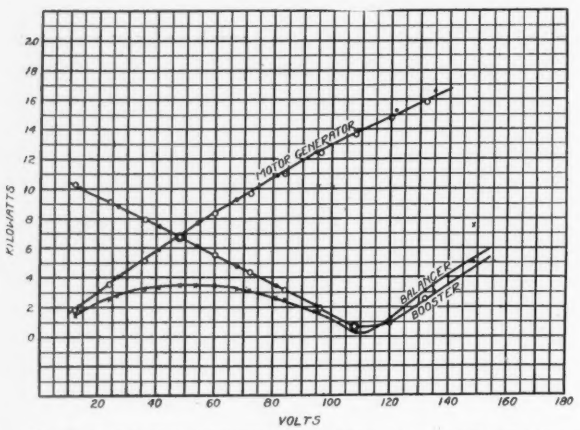


FIG. 4. RELATION BETWEEN CAPACITY AND VOLTAGE OF MOTOR END OF BALANCER WITH CONSTANT CURRENT OF 100 AMP.

that no further correction need be applied and is considerably lower than would be required with either a motor-generator or booster set.

At first glance, it may be a little difficult to understand that by reversing the field of machine B the voltage of A is raised above that of the supply line and the battery charged at that voltage with a smaller current than that flowing in the mains. In this case, the voltage B being reversed, the difference in voltage between A and B must be that of the line. In fact, we now have an ordinary booster set with the exception that the motor is connected across the battery leads instead of across the mains as is the ordinary practice; this is made clear by reference to Fig. 3 which is identical in connections with Fig. 2, but so arranged as to bring out the boosfer feature. Calculation of the size of motor is almost the same as in the preceding case. Assuming the battery to consist of 60 cells, the maximum power required becomes 60 × 2.25 × 100 = 13,500 w. Current taken from 115-v. line at 100 per cent efficiency = 13,500 ÷ 115 = 117.4 amp., which is also the current in armature B. The power developed in armature B is therefore 117.4 × (135 — 115) = 2348 w., which in this case is the output of the set. At an over-all efficiency of 67 per cent, the input must be 2348 ÷ 0.67 = 3504 w. and the losses 3504 — 2348 = 1156 w., which would require an additional current from the line of 1156 ÷ 115 = 10.1 amp. The total line current is now 117.4 + 10.1 = 127.5, which increases the power in armature B to 127.5 × 20 = 2550 w. and that in armature A to 2550 ÷ 0.67 = 3806 w., which is a slightly higher value than would be necessary for the ordinary booster connection for the reason that the current has been subject to the losses in armature B before reaching armature A. A second correction for the increased losses due to the increase of line current might be applied, but would be so small as to be insignificant.

Figure 4 shows the kilowatt capacity of the motor end required to furnish a current of 100 amp. at various voltages when operating on a 115-v. power circuit and using the motor-generator, booster, or balancer. The overall efficiency has been assumed to increase with the size of the set to a maximum of 83 per cent for the largest motor-generator set shown on the curve.

In the case of the balancer, as in that of the booster, the motor-generator has the advantage of being able to operate at any voltage from zero up to the maximum for which it is designed. The booster set also has an advantage in that its motor is wound for the standard voltage and may therefore be used as a low voltage motor-generator if the occasion requires. In assuming a charging voltage of 2.25 v. per cell, one will generally be able to obtain regulation up to 2.5 v. at reduced current and down to 2 v. at the same current without affecting the size of the set, although the exact conditions should be specified in ordering. If a greater range of voltage is required, the size of the set will increase with the range and the advantage over the motor generator correspondingly decrease, although it will never entirely disappear. This is illustrated by the table, where the same line voltage and charging current are assumed but, on account of the indeterminate size of the set, 100 per cent efficiency is assumed.

CURRENT VOLTAGE RELATIONS OF BALANCER SET

Charging	—Armature A—		—Armature B—	
voltage	Volts	Amperes	Volts	Amperes
150	150	31	35	131
140	140	22	25	122
130	130	13	15	113
120	120	5	5	105
115	115	0	0	100
110	110	4.2	5	95.8
100	100	13	15	87.0
90	90	21.7	25	78.3
80	80	30.4	35	69.6
70	70	39.1	45	60.9
60	60	47.8	55	52.2
50	50	56.5	65	43.5
40	40	65.2	75	34.8
30	30	73.9	85	26.1
20	20	82.6	95	17.4
10	10	91.3	105	8.7
0	0	100	115	0

It will be noted that a set designed to operate above

line voltage will not be overloaded by reduction in voltage until it has fallen the same distance below line voltage. In the immediate vicinity of line voltage, a small change in the operating voltage involves a considerable change in the armature current and voltage; between 110 and 100 v., the current in A rises from 4.2 to 13 while the voltage in B rises from 5 to 15. To obtain a range of from 150 to 0 on armature A would require nearly the same armature as the generator of a motor-generator; the maximum current and maximum voltage would be the same; but, as only 31 amp. are required when operating at maximum voltage, the size of the machine might be slightly reduced. A still further reduction in the size of the units might be obtained by interchanging A and B after the 60-v. rate has been obtained, or what amounts to the same thing, switching the battery from A to B. It will be noted in the table that the readings for A below 60 v. are well within the capacity of B for readings above 60 and vice versa. Unit A would then have a maximum voltage of 150 and current of 47.8 while B would have a maximum current of 131 amp. and a maximum voltage of 55; neither armature would be required to give maximum current at maximum voltage.

The balancer strongly resembles the booster in respect to operating troubles and safety devices required for adequate protection. Like the balancer, one side of the battery is connected to the power system, with the result that more trouble may be anticipated from grounds than with a motor-generator. There is, perhaps, less danger of excessive speeds, especially when a rheostat is used that raises the current in the field of one machine while lowering it in the other; but there are still a number of possibilities that may produce racing; these depend to such an extent upon the operating voltage and method of connecting that there is but little use in a general discussion; the individual case, however, should receive careful study.

Failure of line voltage has much the same result as with a motor-generator; the battery will drive armature A as a motor, armature B becomes a generator and the tendency is to maintain the line voltage at somewhere near its original value, the battery furnishing the amount of power necessary to carry whatever load may be on the line which is likely to be sufficient to produce injurious effects upon the battery itself or upon the balancer set. The effects of short circuits deserve special consideration, as they are somewhat different than on sets previously considered. A short on the battery or armature A throws the entire line voltage upon armature B with a tendency to increase its speed in proportion to the increase in voltage, while A, on account of its separately excited field, is subjected to a very heavy current; if no circuit is opened, both armatures will be quickly burnt out. If the circuit of A is opened in such a manner as to leave the short in series with B or by opening a circuit breaker placed at the point C in Fig. 2 when the short is on the battery circuit, the set speeds up through the action of line voltage on armature B; if B is designed for a low voltage, the safe speed limit will be quickly exceeded.

Much the same results may be obtained by short-circuiting armature B, which may occur through grounds on the main line and battery circuit as at the point G of Fig. 2. With the above ground combination and the circuits through both the battery and armature B open, the excess voltage on armature A may readily cause the set to race with a current of less than that required for normal operation, overload circuit breakers offering no protection. Switches and circuit breakers may be so arranged, or interlocked, that such a combination as the preceding is practically impossible, or an additional safeguard may be provided by the installation of a centrifugal attachment for opening circuit breakers in the main line. The saving in first cost and in efficiency of operation that is nearly always effected by the balancer set should at least insure that it be given careful consideration in selecting a battery charging outfit.

Rotary Converter Adjustable Speed Sets*

Application to Rail Rerolling Mills of the Calumet Steel Co. By L. H. Hook and F. R. Burt

ELECTRIFICATION of the rolling mills of the Calumet Steel Co. at Chicago Heights was completed, and the equipment put into operation approximately a year ago. The mills electrified are an 8-in. five-stand mill, and a 14-in. seven-stand mill.

The 8-in. mill was formerly driven by an 18 by 30-in., 120 to 150 r.p.m., simple non-condensing steam engine, through seventeen 1-in. ropes. The pulley ratio was 108 in. to 48 in., giving a mill speed of 270 to 337 r.p.m. A 14-T., 11-ft. diameter flywheel was mounted on the engine shaft. This mill is of the simple merchant type, and is used for rolling small orders of varied product which cannot be produced economically on the 14-in. mill.

The 14-in. mill was designed for rerolling rails into concrete reinforcing bar, tubes for fence posts and bedsteads, small structural shapes, etc. It consists of a seven-stand train, split into two drives. Five stands are driven from one end, and two stands with two additional stands of forming rolls from the other. The forming rolls are set in tandem after the bull head, and are driven by gears from the main shaft. They are used for shaping tubes, and require only a small amount of power.

This mill was formerly driven by two duplicate 26 by 48-in., 80 to 95 r.p.m., simple non-condensing steam engines, by means of sixteen 1½-in. ropes. The corresponding mill speeds were 160 to 190 r.p.m.

In electrifying the 8-in. mill, it was decided from past experience with the steam drive, that adjustable speed was not required, and a constant speed, 292 r.p.m. motor of 500 hp. capacity was installed, direct connected to the mill through a flexible coupling. The control for this motor is of the magnetic secondary type, with a hand operated double throw primary circuit breaker. This breaker is operated from a panel located near the mill, and the drive is started and stopped, or

* Abstract of paper read before the Chicago Section of the Association of Iron and Steel Electrical Engineers.

plugged when necessary by the roller or other authorized mill man.

With the electric drive, the tonnage on this mill has been markedly increased, having been almost doubled on certain schedules. In 384 hr. operation, delays of 71 min. have been charged to the electrical equipment. This is 0.3 of one per cent, based on the operating time.

The steam engines on the 14-in. mill were replaced by two duplicate 1000 hp. rotary converter adjustable speed sets of the constant horsepower type. It was thought advisable to have more speed adjustment than could be obtained from the steam drive, and accordingly these sets were designed for speeds of 450 to 590 r.p.m. Each is connected to the mill through a flexible coupling and a herringbone gear unit, specially designed with a

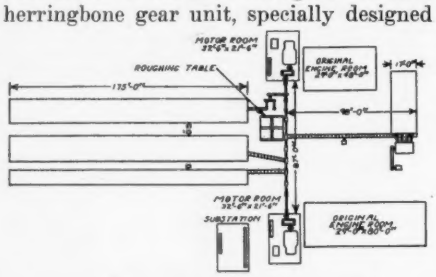


FIG. 1. LAYOUT OF 14-IN. MILL

short center distance between gear and pinion shafts. The reduction is 3.1 to 1 giving a mill speed of 145 to 190 r.p.m.

Each of these electric drives consists of a main wound rotor induction motor, a smaller direct current motor direct connected to it, and a rotary converter.

PRINCIPLE OF ADJUSTABLE SPEED INDUCTION MOTOR

IN ANY scheme for securing adjustable speed on induction motor, one of the auxiliary machines must be

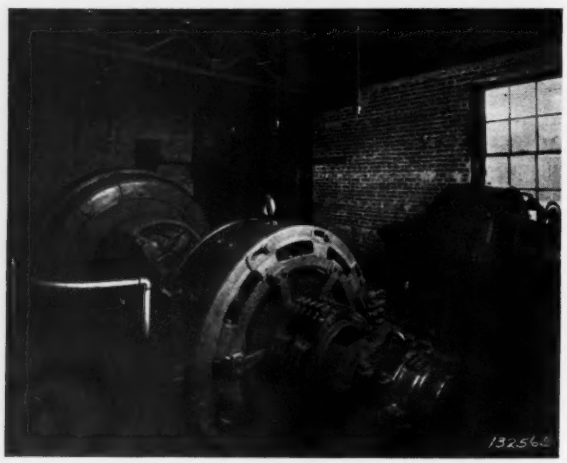


FIG. 2. 1000-HP. DRIVE FOR 14-IN. MILL

mounted on the same shaft if the advantages of constant horsepower throughout the speed range are to be obtained. An induction motor in itself is essentially a constant torque machine—that is, with a given current in the windings, the same torque will be exerted at all times, regardless of the speed. An induction motor exerts torque by virtue of the interaction of the current in the secondary and the flux set up by the primary. To circulate current in the secondary, there must be a voltage generated, and this voltage is produced by a difference in speed between the rotating field in the primary and the mechanical rotation of the conductors of the rotor. The voltage generated is directly proportional to this difference in speed or "slip."

If it were possible to operate an induction motor at exactly synchronous speed, there would be no voltage in the secondary, consequently no current could flow, and the motor would produce no torque. If a load were thrown on this motor, it would not be able to carry it, and would immediately start to slow down. This slowing down would cause a difference in relative speed of flux and conductors, which would generate a voltage in the secondary. This voltage would circulate current, and the motor would immediately begin to exert torque. At some certain point, during this slowing down process, a point is reached where the torque exerted by the motor is just enough to carry the load, and the motor operates at this speed until the load is again changed. The

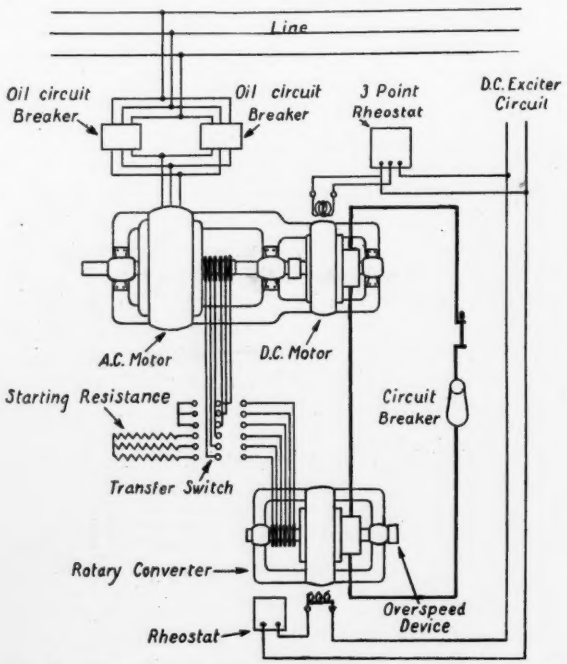


FIG. 3. DIAGRAM OF CONNECTIONS FOR ALTERNATING CURRENT ADJUSTABLE SPEED EQUIPMENT

design of a good rolling mill motor, with short-circuited secondary, is such that a drop in speed of approximately 1½ or 2 per cent is sufficient to allow it to carry full load torque.

If a voltage is introduced into the secondary circuit which opposes the voltage generated by the slip, the motor must slow down to a point where the latter predominates by an amount sufficient to allow the motor to carry the load. For instance, if the locked secondary voltage of a motor is 1000, and it drops 2 per cent in speed at full load, it indicates that 20 v. are required in the secondary to allow full load current to circulate. If now a counter voltage of 180 v. is impressed, the motor must generate 200 v., or must drop 20 per cent in speed. The result is the same whether this counter-voltage is obtained from an external source, or whether it is due

to resistance in the circuit. A resistance drop may be considered as a counter-voltage, since it absorbs a portion of the generated voltage.

Any desired speed from full speed down to standstill can be obtained by inserting the proper amount of resistance in the rotor circuit, but this speed with a given amount of resistance can be obtained only at one value of load, since at any other load, the rotor current, and therefore, the counter-voltage of IR drop are different. In other words, resistance in the secondary circuit simply exaggerates the natural speed characteristic of the motor, which varies from full load speed to synchronous speed, depending on the load. Since the induction motor delivers the same torque with a given rotor current, independent of the speed, it follows that the horsepower is directly proportional to the speed. The horsepower input from the line is constant, and the difference between the input and output, except for the internal losses in the motor, appears at the rotor slip rings. If the speed reduction is secured by means of secondary resistance, this energy is dissipated in the form of heat and is lost.

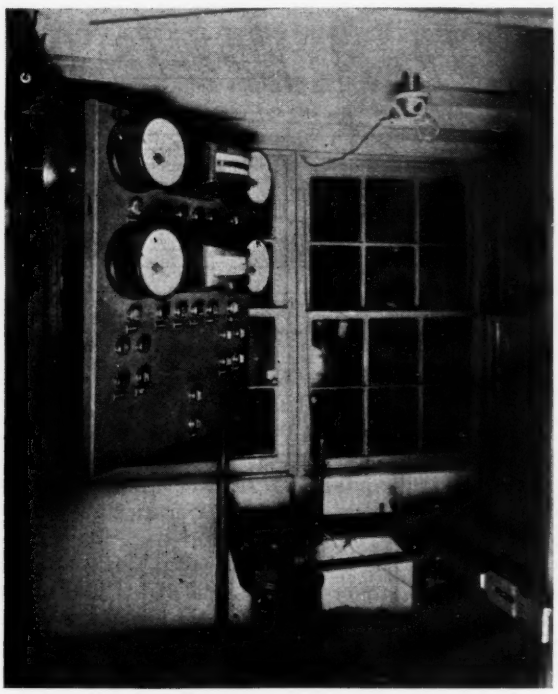


FIG. 4. EQUIPMENT IN PULPIT

In order to obtain definite speeds which will not vary under changes of load, it is necessary to keep the counter-voltage constant by taking it from an external source, and this voltage must at all times be the same in the frequency and phase position as that generated by the rotor, if the system is to be operative.

Hence, there are three prime requisites for a successful and economical alternating current, adjustable speed equipment.

(a) An easily controlled voltage must be impressed on the rotor.

(b) This voltage must be of the proper frequency and phase displacement.

(c) The energy in the secondary due to the slip must be conserved.

All alternating current adjustable speed sets are designed with these three objects in view, although they may differ in the type of auxiliary machines used, and in the use made of the slip energy. There are two main classes of sets. One delivers constant torque throughout the speed range, and the other delivers constant horsepower. An equipment of the former class feeds the slip energy back into the line, simply circulating this amount of power through the machines. Equipment of the constant horsepower type delivers the slip energy

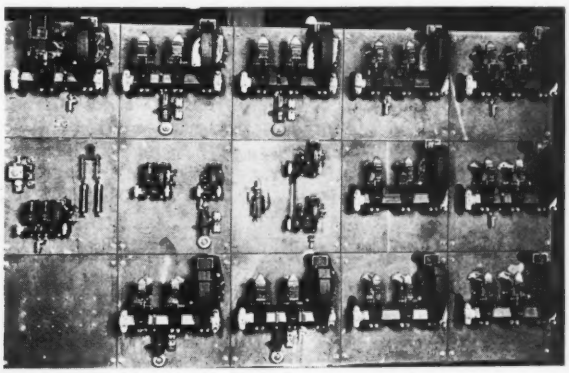


FIG. 5. SECONDARY CONTROL BOARD

back to the shaft, increasing the torque in proportion to the speed reduction. The machines at the Calumet Steel plant are of the latter type.

Operating Features

On each set, the main 1000 hp. induction motor delivers $\frac{450}{590} \times 1000$ or 763 hp. at the low speed. The input at all speeds corresponds to 1000 hp. output. The difference between the input and output, in this case 237 hp., appears at the slip rings, and is transferred through the rotary converter, where it is converted to direct current and impressed on the direct current motor. The direct current motor changes it to mechanical energy, increasing the torque on the shaft and bringing the total output up to 1000 hp. On this mill, small rails designated as 4-in. or less, are rolled at the high speed, while the slow speed is used for the largest rails. Rolling from 5 and 5¼-in. rails requires considerably more power than reducing the smaller sizes, hence the constant horsepower drive fits in admirably on this type of mill.

Starting and speed adjustments of these drives are accomplished from the master switch, and a rheostat control switch. With this master switch in the "off" position the primary and secondary circuits of the main motor, the direct current circuit between rotary and direct current motor, and the field circuit leading to the rotary and direct current motor, are open. Moving the master switch to the first position closes the contactors which connect the secondary of the main motor to the starting resistance, provided the direct current motor field rheostat is in the "off" position, and the speed

limit device on the rotary converter is set. The second point on the master switch closes the primary contactor, which, in turn, releases the first accelerating relay in the secondary circuit. The motor now comes up to speed, the secondary contactors which short-circuit the resistance being controlled by current limit relays, so that the current is maintained between predetermined limits during acceleration.

The operation at this point is that of an induction motor with short-circuited collector rings, and if it is desired to roll at the high speed, the master switch is left on the second point. The rotary is connected to neither of the other machines, and the field circuits are open. If it is desired to operate at reduced speed, the master is moved to the fourth point. The third point closes the field circuit to the direct current motor, whose rheostat is in the "off" position, and to the rotary converter whose rheostat is set for normal field current. The fourth point disconnects the secondary circuit of the main induction motor from the resistance, which is now short-circuited, and connects it to the slip rings of the rotary converter. The regulating circuit is now completed, but since there is no counter-voltage being generated, the only effect on the speed is that of the very small resistance introduced in the rotor circuit by the other machines. The main induction motor is rotating at nearly synchronous speed, and therefore is generating practically no secondary voltage. The direct current motor, although running at full speed, has its field unexcited, and therefore is delivering only a very small voltage, depending on its residual magnetism. The rotary converter, although its field is fully excited, has very little voltage across its terminals, and therefore is at a standstill, or very nearly so.

If, however, a field is now put on the direct current motor by moving the control switch which operates the motor-operated field rheostat, a voltage is generated which is impressed on the rotary converter, and through it on the secondary of the main motor. The machines are so connected that this voltage opposes that of the rotor, which must slow down and increase its slip voltage. When the latter becomes enough more than the impressed voltage to allow a current corresponding to the torque to flow, a point of equilibrium is reached, and the set operates continuously at this speed, with small variations under load, until the setting is again changed. Any speed within the range can be contained by manipulating the rheostat control switch. If in case of emergency, it is desired to stop quickly, the master switch and control switch are brought to the "off" position and the master moved to "reverse." This impresses full voltage on the primary in the reverse direction and brings the motor quickly to rest.

A pulpit over one end of the mill contains the master switches and speed control switches for both sets, and also an operator's panel. On this panel there are mounted indicating wattmeters showing the input to both drives, and a voltmeter and ammeter in each direct current circuit. A system of signal lights indicates to the operator the position of the main incoming line circuit breaker for the plant, the hand operated circuit breaker for each set, and the electrically operated primary reversing contactors, all of which are located in the sub-station, and also of the principal contactors in the secondary circuit, which are located in the motor rooms. This control apparatus could have been mounted on the mill floor and operated by the roller, but it was considered that the time saved by having an operator on the job who had no other responsibilities would more than pay his wages.

Rapidity with which the speed of these sets can be changed, and their stability under such conditions, are shown in Fig. 6. The upper chart is kilowatts input and the lower is revolutions per minute. The zigzag line on the upper margin of the lower chart represents time in seconds. In taking these readings, the field rheostat was turned by hand as rapidly as possible from one maximum position to the other. It will be observed that

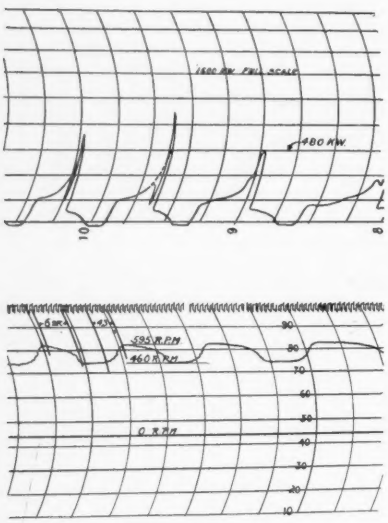


FIG. 6. RECORDS SHOWING RAPIDITY OF SPEED CHANGES

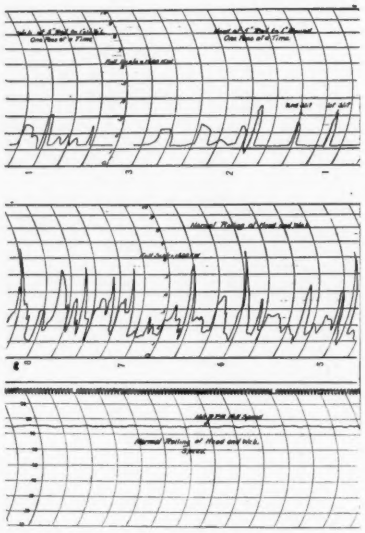


FIG. 7. RECORDS TAKEN WHILE ROLLING 5-IN. RAIL IN FIVE-STAND MILL

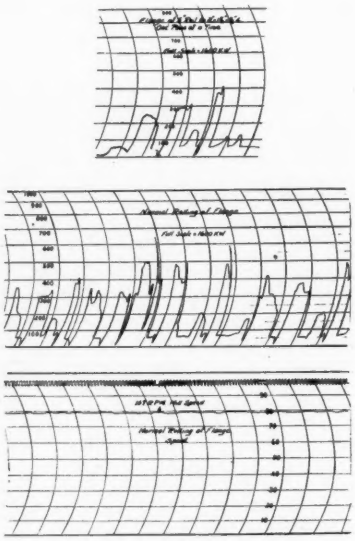


FIG. 8. RECORDS TAKEN FROM THE TWO-STAND MILL DRIVE

the speed was increased from minimum to maximum in 6 sec. with an input of 480 kw., and that it was decreased from maximum to minimum in 4.3 sec. The regenerative power during this operation is not indicated, as the pointer was against the stop on the meter.

Power for operating these drives is supplied by the local power company, the Public Service Company of Northern Illinois. It is brought into the substation on the property at 4000 v., which is the voltage used on the motors. In the substation are the main incoming line circuit breaker, the feeder breakers for the three mills, the "forward" and "reverse" primary contactors for the 14-in. mill drives, switching and transforming apparatus for the low voltage mill circuit, and a small exciter set, which supplies direct current excitation for the sets.

The first chart in Fig. 7 shows the kilowatts input to the five-stand drive when rolling the head of a 5-in. rail to a 1-in. round, and the web to a 1 by 1 by ⅛-in. angle. One piece alone was run through the mill, and the power required for each pass recorded. The second chart was taken during normal rolling on the above sizes. It illustrates the building up of peaks by overlapping passes with several pieces in the mill. The maximum swing shown is 1000 kw., whereas the maximum taken by a single pass is 580 kw. The third chart indicates revolutions per minute, and illustrates the very small drop in speed of this set under load.

Figure 8 shows the same readings taken on the two-stand drive when rolling the flange to 2 by 1½ by ⅛-in. angles. The maximum peak under normal rolling is again 1000 kw. and the maximum individual pass 640 kw. Unfortunately, one of the heavier schedules was not being rolled at the time these graphic meters were connected in the circuit. During the hardest rolling, it is not unusual for the indicating wattmeter pointers to go off the scale at 1600 kw., which is about 80 per cent overload.

In 2700 hr. operation on the two 14-in. mill drives, delays due to the electrical equipment have been 5 hr. and 52 min., or 0.2 of one per cent. This delay time includes one or two occasions when the power was temporarily interrupted. Readings taken over a period of 8 hr. indicate that to roll 5-in. rails, the head being reduced to 1½ by 1½ by ⅛-in. "T" section, the web to 1 by 1 by ⅛-in. angle, and the flange to 1½ by 1½ by ⅛-in. angle, requires 73 gross kw.-hr. per finished ton, and to roll the same rail into ¾-in. rounds, 1 by 1 by ⅛-in. angle and 1¼ by 1¼ by ⅛-in. angle requires 61 kw.-hr. per ton. It is of interest to note that the total power consumption since electrification has been 88.5 kw.-hr. per finished ton of product. This includes all the electric power used in the plant.

Maintenance and repairs on these drives during the year have amounted to $65.19, of which amount $60.00 was labor. This does not include the oil used in routine oiling of motors, but does include some used in switches.

The increase in tonnage with electric drive has been estimated at 10 per cent due to better maintenance of speed and greater ease of handling the drives. This is felt to be a very conservative figure. It has also been found that the roll breakage is less since electrifying. Since the heating furnace was changed over to powdered coal at about the same time, and more even heating is now being obtained, it is probable that this decrease in breakage is not entirely due to the drive, but the more even torques and higher finishing temperatures due to better speed maintenance undoubtedly have their effect.

All There

By A. Ulmann, Jr.

LONNY closed the door of the boiler-house behind him and shivered as the cold, clammy night enveloped him in its dense, impenetrable mantle of fog. Water dripped from every cornice and post and the wire overhead where they passed through the shafts of light thrown by the boiler-house windows, glistened with long rows of twinkling diamonds of moisture which one by one detached themselves to fall to the ground and make more liquid the already viscid clay, and enlarge the fast growing puddles.

The great chemical plant lay sullenly throbbing beneath this horrid fog and the nauseous fumes of acid and other things more deadly were returned to earth by the moisture-charged atmosphere in an ever growing concentration to make the night stifling and hideous to those who toiled within the iron-fenced enclosure. A pungent, stinging breath assaulted his nostrils from the sneeze-gas plant hidden in the fog to his left as he switched on his hand torch and began slowly to cross the yard, picking his way between piles of construction materials and carefully avoiding the pipe ditches still open.

Although scarcely finished, the plant was in full operation, feverishly turning out the necessities of war. Materials, almost as deadly to the one who handled them as to the enemy whom they were destined to destroy, were scarcely to be confined, and danger and death lurked in every stagnant corner of the yard.

As he entered the brightly lighted pump house the auto-call bell began to ring out in doleful iteration, "one-three," "one-three," the shift engineer's call, and its continued clangor seemed to carry a menace of trouble. Lonny passed through the pump house and into the switch house to his own desk telephone, where he would be away from the noise of the machinery.

"Hello, hello, engineer in charge?" came over the phone in a tired, far-away voice.

"Yes, this is Carmichael, engineer in charge. Who's speaking?"

"Load despatcher, Pennsy County Electric. Can you cut your load down 10 per cent?"

"Well, hardly; we're very busy," Lonny replied doubtfully.

"Yes," the voice answered sarcastically, "you're all busy and you'll all be busier yet if someone doesn't come across. This fog is playing hell all along the high-tension lines and we can't hold the overload much longer. If you don't take off some of the load soon, you'll all be dumped. Get me?"

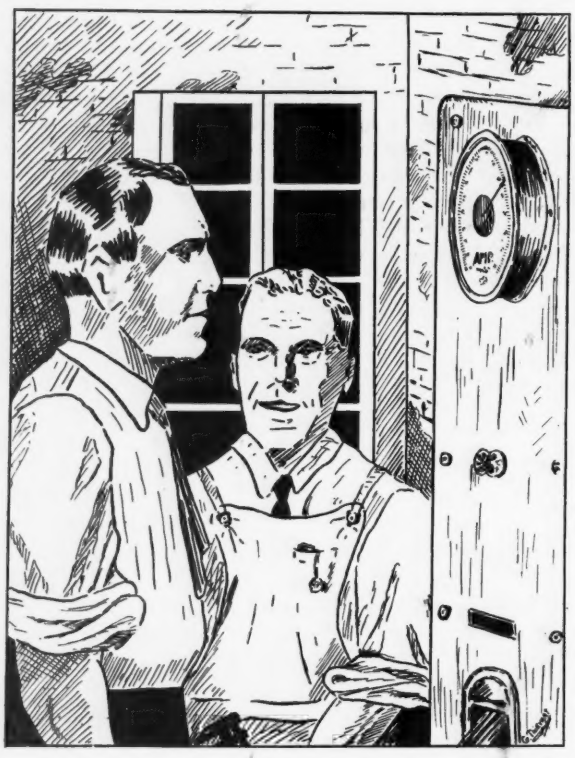
"Yes, I get you and I'll do what I can, buddy," replied Lonny. "I'll take a chance and shut down the

coal conveyors and the refrigeration plant. That'll be about 150 horse."

"Fine," came the voice, "I wish some of these other birds had some of your brains. Bye, Carmichael."

"Bye, buddy, you're welcome," said Lonny, and thoughtfully held the receiver hook down until he heard the single bell tap that told him that his phone was clear. Then he called the operators and gave them instructions as to what to shut down, and then called the phone operator to ask him to get Mert Williams, the shift foreman, on the auto call and ask him to come to the engineer's office as there was trouble.

Lonny's job was anything but enviable. A boy of but 22 yr., fresh from college, he had been pushed ahead by circumstances in little more than 6 mo. until he found himself one of the three shift engineers of the Amalgamated Dye Works, a position that would have made a far more experienced man quail. The



THE AMMETER DROPPED BACK AND BACK UNTIL IT REACHED 100 AND THEN STOPPED

draft, higher wages paid elsewhere, and now the flu had taken man after man and left the force so crippled that the chief, Mr. Lawson, was put to desperate straits to find men and keep the plant running. In his extremity Mr. Lawson had turned to Lonny and given him a trial, as he had the education necessary but little if any experience.

So Lonny was on trial, and it was a bitter, hard struggle. Nothing seemed to go right. Every trick of duty was just one succession of "one damned thing after the other." The equipment was all new, untried, stiff and a good part of it was installed in a most slipshod and incomplete manner. Construction was going on and constant vigilance was required to see that the contractors kept clear of steam, water and power lines and carried on their work so as not to interfere with the operation of the plant. Worst of all, however, was the distrust and jealousy of the other foremen. They disliked him because he had been advanced so rapidly and feared that through youth and inexperience he would do something that would cripple the plant and perhaps reflect on them. So in every covert way possible they hampered him and made it doubly hard to show what he could do.

The situation that Lonny was in this night was critical; he realized that and nervously awaited Mert's appearance. The lights flickered a little and he got up and walked out in front of the switchboard to peer anxiously at the indicating instruments, and what he saw only added to his anxiety. The voltage was low, registering only 11,500 in place of the normal 13,000, and the voltmeter needle flickered back and forth in a most alarming manner. The ammeters all showed very high readings and they too were afflicted with St. Vitus dance as their pointers jumped back and forth in ever-increasing regularity.

Mert stumbled up out of the fog and explosively exclaimed: "What the blazes is this, kid? What are you shutting down for? Don't you know we are up against it and can't afford to lose a minute?"

Lonny bit his lips and held his temper in check as he answered evenly, "Mert, if something is not done soon we will be shut down entirely. This fog is playing the devil with the electric lines and the load despatcher called up and asked us to cut down as he feared that they could not hold it much longer. I sent for you to see if you could not cut off some of the process in addition to what I have already done."

"Not so much as one light goes off, kid. If you're scared by the yap of that nutty load despatcher, I'm not. I've been around this plant now long enough not to let every dough-head scare me with such old woman's yarns. They are always in trouble and nothing ever comes of it."

"Well, Mert," Lonny returned, "you know what will happen if the power goes off. Everyone of your aniline stills will be stuck solid in 5 hr. We can't begin to keep all 40 stills turning over with our little 500 kw. stand-by unit and the rest of the plant must be shut down entirely. I am not willing to take a chance and I feel that we should do all in our power to avert the trouble; however, use your own judgment; don't let me interfere."

Mert's eyes narrowed and his face grew red with rage. "Kid, are you passin' the buck to me? I'll use my own judgment, and use it ———."

Lonny's pale face suddenly disappeared from his sight in impenetrable darkness. So sudden was the change that their eyes pained intensely with the effort of focusing to the new condition, and Mert's mouth stopped open for some seconds. Two heavy jars sounded like dull explosions behind them as the heavy line switches were released by the no-voltage trips. For a moment intense silence reigned, more intense even than the darkness, and they stood as if petrified until finally the factory whistle broke the spell as it bellowed out the "power off" signal. Lonny sprang into the transformer room and returned with the emergency lantern

and hurriedly cleared up the switches on both boards. Then he turned to Mert and said, "Hurry and get everything clear before I put on the stand-by and give you light."

Mert turned and bolted out of the door and his electric torch showed his stumbling progress through the blackness as he hurried toward the process buildings. At that moment the electrician came in and took his place in front of the switchboard, saying, "All right, Lonny, on the job!"

"Give 'em light only when I close the feeder switch," Lonny instructed him and then hurried out to the pump house where the stand-by unit was located. As he entered he saw with satisfaction that Pat already had the little turbo-generator up to speed.

In another instant the lights flashed on and they both inspected the machine carefully to see that everything was working properly. Satisfied of this, the signal for "power on" was blown and they settled down to the ticklish job of nursing the little turbine through hours of a grueling overload.

He soon saw that the trouble was commencing. The ammeter needle climbed up and up as Mert put on still after still. It reached the rating mark at 126 and kept on. Up and up it went until the turbine began to slow down and groan and the lights began to grow dim. It stopped at 160 and pretty soon Mert came in to ask anxiously why the lights dimmed. He only had 30 of the 40 stills operating and had not started any more as he feared it would be too much.

"That's all you can carry, Mert," Lonny told him. "This poor little machine can't do any more. You are pulling an overload on every still and the power factor is simply awful. The whole load is inductive and there is nothing to be done."

"My God, man," Mert groaned, "we'll lose half the stills. Some of them are sticking now."

"The only thing I can think of," Lonny explained listlessly, "is to alternate the stills and so you may be able to run all of them enough of the time to keep them from sticking altogether. This will mean an awful loss, but I cannot build machinery over night."

He was so tired that he felt as if it did not much matter what happened. Mert looked about him dully and turned and shuffled out to gather all the men he could to turn the stills by hand and thus try to save a few of those that were not running. He knew what that meant. Rebellion would break out among the men at once as soon as they heard the order for such grueling, hard work.

Lonny's tired brain writhed under the goad of his will, but connected, logical thought refused to come and the throbbing roar of the little turbine seemed to deafen that part of his brain where was stored his mechanical knowledge to the despairing calls of that other part which controlled his actions and desires. His tortured mind refused to figure, but the thought kept returning again and again, suppose there was something he could do that would be obvious to a more experienced man and that he through ignorance was letting the opportunity slip.

Mert burst into the pump house, hatless, his slicker discarded and his clothes soaked and muddy. He rushed up to Lonny and with his eyes fairly popping out of his head, and face purple, he exploded and let loose the full torrent of his pent-up feelings.

Lonny was completely aghast by the suddenness of this outbreak and although his impulse was to jump on Mert and wipe up the floor with him, he controlled himself with difficulty and turned and walked down the room. Pat, who was standing near, looked from one to the other with a curious expression on his face. His grip tightened on the heavy wrench in his hand and for a moment he gazed intently at the top of Mert's head and his arm twitched upward a few inches as if aching for the blow; but it dropped again and Pat, disgust in every line of his face, turned away about his work.

On either side of Lonny stretched the long line of pumps, now silent and still, as there was not enough power to keep them running. At the far end stood a new unit, just installed, untidy with the odds and ends of construction material strewn about. He stopped and looked at it mechanically as his brain boiled and smarted with Mert's unjust words. It was a large synchronous motor direct connected to a centrifugal pump and had just been run for a few minutes the day before. In a flash he remembered the words from a text book, read long ago, and as he closed his eyes for a moment the text stood out clear and distinct before him.

"A synchronous motor running without load may be used to rectify a lagging current produced by an inductive load. If this field be overexcited, it will cause a leading current to flow and thus rectify a poor power factor."

He ran up the room and grasped Mert's elbow in a grip that made him wince and brought him out of his lethargy. "Run, Mert, and get that booze-hound of a mechanic! I may be able to get you out of this hole," he cried.

Mert's head came up with a jerk and one look in Lonny's face was enough. He turned without a word and bounded out of the building in search of the night mechanic. Almost before Lonny had time to crystallize in his mind his mode of procedure, Mert returned with the mechanic and an electrician at his heels. In a moment they were at work as Lonny issued his crisp commands.

"Jim, take those coupling bolts out of that new motor and leave her free so that I can run her light. You, electrician, I don't know your name, go over those connections and be sure that motor is O. K. to run. Pat, see that there is oil in the bearings and that there are no tools or other things to foul when we start up." In a few minutes all was ready and the electrician stepped up to the starting board of the motor; in a moment it was humming at full speed.

Then Lonny told him to cut out resistance slowly in the field circuit and called Mert to watch the ammeter on the turbine board. He was filled with anxiety. Would it work? Had he found the cure? Yes, the ammeter pointer began at once to go back. The lights resumed their full brilliance and the turbine's tone changed as it began to work more easily and regain its full speed. The pointer dropped back and back until it registered 100 and then stopped. Lonny signaled the electrician to stop and turned to Mert. "Go start all your stills now and the gas house too if you want."

"Right, sonny! On my way," and Mert was off.

Half an hour later, when Mert returned, the amme-

ter registered only 148. An overload still, but well within the working limit of the turbine. He was smiling as he reported that all the stills were running and that only four were in a dangerous condition.

"Will she hold it like that?" he asked anxiously.

"Sure, unless something else happens," Lonny replied.

Then Mert hesitated a moment, tried to say something. He cleared his throat once or twice, but could not seem to get out what was on his mind. Finally, a little shamefacedly, he stuck out his hand and blurted, "Lonny, put it there! I was a bit rough, but I was awful worried."

"Right, Mert," Lonny grinned self-consciously, as he grasped Mert's hand. "I felt about the same myself. How about some coffee and a bite? I'm all in."

Pat saw what was going on and, with a grin, ducked behind the machine he was oiling. "Bad cess to me wild Irish timper," he chuckled. "The kid's all there. He was right and Oi was wrong. If Oi'd brained thot spalpeen wid me wrench, O'd uv spiled the party entoirely."

Eliminating Noise in Heating Systems

CHANGES IN PIPING AND JUDICIOUS USE OF TRAPS ARE PRINCIPAL REMEDIES FOR NOISE. BY H. A. JAHNKE

IT FREQUENTLY occurs that we have trouble in one way or another with some part of the heating system in our charge, the cause of which it is quite difficult to locate at times, making it necessary to call in outside help to remedy the trouble.

It is the writer's intention to relate some of the trouble he had with the heating systems under his charge and how these troubles were remedied.

CAUSE OF CLICKING NOISE IN RETURN PIPE

IN THE main office of a manufacturing plant, it was necessary to install more radiators to obtain the proper temperature in certain rooms during very cold weather.

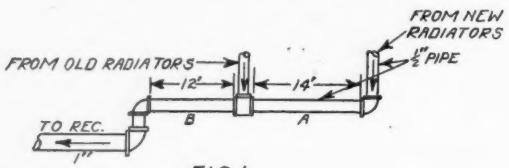


FIG. 1

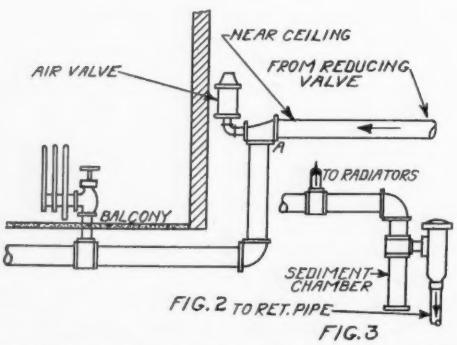


FIG. 3

FIG. 1. RADIATOR CONNECTION WHICH CAUSED CLICKING
FIG. 2. AIR VALVE STOPPED NOISE IN PIPING
FIG. 3. PLACING LARGER TRAP IN THIS LOCATION STOPPED NOISE

After the installation was completed and steam turned into the system, there was more or less noise in some of the return pipes which was very annoying to the office employes and management.

Nobody seemed to know what caused the trouble, but on investigation it was found that when more radiation was installed in some of the rooms the fitters had connected the ½-in. outlet from one of the new radiators into the ½-in. outlet of one of the old radiators, as shown in Fig. 1. This made two ½-in. return pipe discharge into one ½-in. pipe, and I was under the impression that this was the cause of the noise, as it was my idea that in the two ½-in. outlet pipes from the two radiators discharging into one main pipe, this main pipe was continuously filled with water and when one of the radiator traps discharged and a little steam leaked by it would cause the clicking noise when the steam came in contact with the water in the main line at A and B.

As a remedy, the ½-in. pipes A and B between the outlets of the two radiators were replaced by 1-inch pipe. After this change, there was no more noise in any of the return pipes, caused by water hammer.

ANOTHER NOISY HEATING SYSTEM

IN ANOTHER heating system where live steam is used, which is reduced from 120 lb. to 10 lb., there always was more or less clicking noise. Many changes were made in the piping layout, but with no results.

It will be noticed in Fig. 2 that the pipe feeding the radiators from pressure regulator is located near the ceiling of the building until it comes to the wall of an enclosed balcony, then down and along under the balcony floor. In examining this pipe and radiators, I came

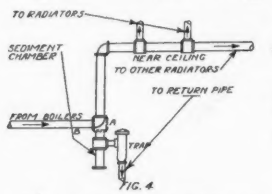


FIG. 4

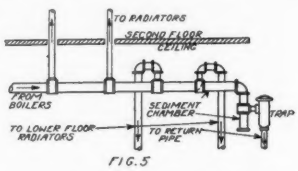


FIG. 5

FIG. 4. TRAP PLACED AT BOTTOM OF RISER STOPS NOISE
FIG. 5. TRAP TO DRAIN DEAD END OF PIPE

to the conclusion that the trouble lay in the main pipe feeding the radiators, as it will be noticed that the horizontal pipe line near the ceiling is much higher than the radiators on the balcony and it was my idea that air would collect at the elbow A; so I replaced the elbow with a tee and placed an automatic air valve as shown, after which there was no more clicking noise in the pipes.

A LARGER TRAP CURED THIS TROUBLE

IN ANOTHER instance when there was much noise in a pipe supplying steam to a number of radiators at a low pressure, the noise was much worse during very cold weather. There was a trap at the end of the steam pipe as shown in Fig. 3, to keep the pipe clear of con-

densation, and at first it was not thought that the noise was caused by condensate coming in contact with steam, so a number of changes were made in the pipe system but with no beneficial results.

The trouble was finally found to be caused by condensate in the pipe which the ½-in. trap at the end of the line could not take care of, and this trap was replaced by a ¾-in. trap. After that, there was no further trouble with noise in the pipe regardless of the weather conditions.

Improper Pipe Installation Causes Trouble

Frequently a heating system is quite noisy, caused by improper installation of the piping, which may be either the feed or return pipes. A case of this kind is illustrated in Fig. 4, where it will be noticed that the feed line from the boiler runs in a horizontal position to a certain point, then rises. There was more or less noise in the feed pipe at B next to where it rises, due to condensation remaining in the pipe when only a few radiators were in use.

When this feed line was installed, there was nothing to interfere with running this in a straight line from the boilers to the radiators, had the fitter used a little judgment or known that forming a pocket in a steam heating system where condensation may collect will cause trouble by water hammer in the pipe.

As it would have taken much time and expense to change the feed line so it would be in a straight line, the trouble was overcome by cutting the pipe near the elbow A and the elbow replaced by a tee, then the pipe was connected together again with a union, and a trap was placed as illustrated, which took care of any condensate that would collect in the pipe, thereby preventing any water hammer. This condensate was returned into the receiver and returned to the boiler, by a tilting trap.

In still another instance, a part of a heating system supplied steam to two radiators on the second floor and two on the lower floor, this being near the end of the feed line as shown in Fig. 5. Whenever the radiators on the lower floor were not turned on, there was much water hammer between the last pipe leading to the second floor radiator and elbow at the end of the line, making it necessary to turn the steam into the lower radiator whether it was needed or not to prevent the noise in the pipe. This not only made it inconvenient for the employes in the lower floor, but also was an unnecessary waste of steam.

To remedy the trouble the elbow A was replaced with a tee, then a small trap was placed as shown. This kept the pipe clear of condensate at all times whether the lower radiators were in use or not.

Why the Pressure Regulators Wore Out Too Quickly

In a certain plant where steam was reduced to the heating system by a pressure regulator from 120 lb. to 18 or 20 lb., they used to have much trouble with the regulators not operating properly. They also would wear out quickly, making it necessary to install a new regulator each year, a new type of regulator being bought nearly each time, as it was thought that the type which had been in use and had given out so quickly was of a poor make, and consequently it was condemned.

When the last regulator gave out, it was decided to send this to a shop and have it repaired; but it came back, as it was beyond repairs.

Then it was decided before getting a new pressure regulator to take the matter up with some manufacturer of a good reliable pressure regulator. A salesman was sent up to the plant after advising him of all the trouble with the different regulators that were used during a number of years. After being told what size of regulator had been used and the number and size of radiators and steam coils in use, the concern was told that too large a regulator had been used, which was the reason it wore out so quickly and also was the cause of the regulators not giving good service.

In the foregoing instance, a 1½-in. regulator had always been used whether it was the correct size for the service or not. Nobody in the plant had thought of finding out.

The salesman's advice was that a 1-in. regulator was the size required to give the proper service. After this size of regulator was installed, there was no further trouble.

We may well imagine what unnecessary expense and trouble there had been in this plant due to buying too large a regulator at a much higher price than the smaller

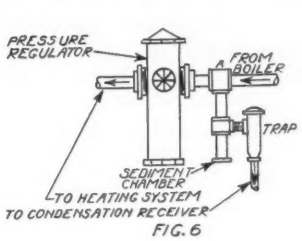


FIG. 6

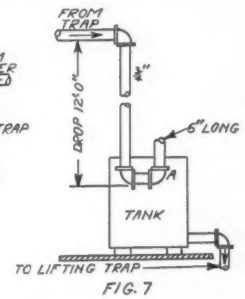


FIG. 7

FIG. 6. TRAP TO KEEP CONDENSATE OUT OF PRESSURE REGULATOR

FIG. 7. WATER SEAL FOR TRAP DISCHARGE

one would have cost, besides the added trouble, and poor service obtained, all due to the fact that nobody in the plant had taken enough interest in the matter, sooner, to find where the trouble lay.

No make of pressure regulator will give good service if it is too large or too small for the service required of it. I have found that the nearer correct a pressure regulator is to the required size for the service, the better service is obtained, also the longer it will last, which in the long run means less trouble and expense.

Keeping Condensate Out of the Regulator

The writer has a pressure regulator in use reducing the pressure to a heating system. When this regulator was installed, it gave more or less trouble and was quite noisy at times. I came to the conclusion that condensate was the cause of the trouble, as the regulator was located a considerable distance from the boilers. I decided to try to keep as much as was possible of the condensate from passing through the regulator in some way, which was done as follows: A tee was placed in the high pressure line as shown in Fig. 6 at A, then a short nipple and another tee to which a small trap was connected as shown; then another nipple was screwed into the

bottom outlet of the tee; the other end of the nipple was closed with a cap. This formed a sediment chamber to prevent any dirt, scale, etc., from entering the trap. After that, there was little trouble with the pressure regulator, less noise and more uniform reduction in the pressure.

The condensate from the trap was discharged into an open tank from which it ran into the tank of a tilting trap which forces it into another tilting trap used for boiler feeding, hence there was no loss of the condensate.

As the trap at the regulator discharges the condensate into an open tank, any little leakage of steam past the trap at times would fill the room in which the tank was located with steam during very cold weather. To prevent this, a water seal was placed at the end of the pipe at the tank as shown in Fig. 7 at A. After that there was little trouble with steam escaping into the room unless the trap leaked badly.

A Few More Reasons Why Pressure Regulators Give Trouble

In many plants where there are pressure regulators in use for air or steam, they have much trouble with them even if they are of the correct size and of a reliable make. In most instances, this is due to carelessness in taking care of the regulator. It would seem as if some engineers and other users of regulators fail to realize that the pressure regulator is an automatic device and as such must receive the proper care to receive proper results. In many instances after the regulator is installed and adjusted to the proper service pressure, it receives no more attention until there is trouble, when it may be too late to make adjustments or repairs. For this reason, a regulator should receive the proper inspection frequently the same as any other equipment in the plant.

Many users fail to install a strainer or sediment trap ahead or in the initial pressure line next to the regulator. This will prevent much of the trouble experienced with regulators caused by dirt, scale, etc., finding its way into the regulator, causing some part to bind, thus preventing the regulator from working properly or causing it to leak.

A strainer or sediment trap costs little, but the results are a big saving in the long run.

Joining the Ends of Leather Belting

By Louis W. Arny

WHERE the plant is large enough, some good mechanic, or some handy man with the mechanical instinct, should be placed in charge of the belts, or where the plant is not large enough for this, the foreman or engineer should take them in charge, and they soon will learn to do the work of making cemented joints on leather belts expeditiously and well. It is only necessary that the belt shall be properly fitted to its pulleys for length, and that there shall be cut on each end the necessary bevel for the lap, and that it shall be cemented properly, and the cement permitted to dry. In the case of small belts, these usually may be cemented and thrown on the pulleys while they are moving slowly. With larger belts it is necessary to use belt clamps, but these need add but little complication.

The tools required are as follows: a square, an ordinary spoke-shave, with a good edge for doing the rough cutting in shaping the bevel. A scraper for finishing this bevel to a smooth surface, and to make a fine point. Possibly some sandpaper to compensate for a poor scraper. A double-jacketed glue pot, with a brush. A couple hardwood blocks, with bolts and nuts, between which the joint may be placed and pressure applied, or a set of bench screws may be used for this purpose. A set of belt clamps of suitable size. Almost all of these can be found in the plant, or a complete set of tools may be bought at small cost from some one of the belting manufacturers, and most of them specify them in their catalogs, and they will supply also the necessary cement, at a small cost.

The requisites are that the two ends must be brought together perfectly square with each other, and that the faces of the joints must be perfectly smooth, and an even bevel from heel to point. If they are bumpy and do not lie flat together, the cement will not stick properly. The latter must be applied hot, and well worked into the fibre of the leather, and pressure should be applied before the cement sets. In the absence of pressure, it will answer if the joint is well rubbed with a tool handle, or a smooth substance, during the process of setting, though pressure is more desirable.

If it is desired to make a joint that will not be affected by dampness, it is necessary to use the Waterproof Belting Cement, which can be obtained from any leather belting manufacturer. With this cement it is necessary to size the leather before cementing; give each part of the lap one, or better, two good coats of the cement, allowing each to dry before applying the next, then to cement these sized joints and bring the two faces of the joint together, and to apply pressure or rubbing as above described.

The leather belt, sufficiently run-in, and fitted to its job, and made endless in this manner, makes a permanent installation, requiring no further attention for a long time, when it may be necessary to "take it up" a little. When this must be done, open the old joint with a screwdriver point, make a new lap on one end, scrape the old cement off the other end to get down to the fiber, and make the joint as before.

An endless joint on a leather belt is as strong as any other part of the belt. It does not weaken the ends of the belt. It is smooth and even, and it will travel over the pulleys, even small pulleys, at high speeds without a jar, and it is durable, for, unless necessary to open the joint to shorten the belt, it will last as long as the belt itself. There is no loss of power, even momentarily, as the belt passes over the pulley.

With the same outfit it is always possible to keep all the leather belts of the plant in perfect condition. The cementing down of a corner of a lap, or the insertion of a small new piece of leather, will indefinitely prolong the life of the belt. Or the belt can be lengthened by cementing a piece to one end, or if not heavy enough for its work, an additional ply can be cemented on it, or it can be cut down to narrower sizes.

Tests are being made at the Southern experiment station of the Bureau of Mines, Tuscaloosa, Ala., to determine the efficacy of low grade dust from Alabama flake graphite for preventing scale formation in boilers.

Compressor Intercooler Complication

MOISTURE IN AIR AT DIFFERENT STAGES OF COMPARISON. BY FRANK RICHARDS

WHAT MAY be said to be the most common and extensive use of compressed air is at pressures ranging between 5 and 9 atmospheres, or say, 60 to 120 lb. gage. This covers practically the entire field of employment of the air for rock drills, pneumatic tools, motors, hoists and the numerous special devices constantly originating wherever a supply of air is handy. The employment of two-stage compressors for such service is now so established and practically universal and so endorsed by experience as wise and economical, that additional argument in advocacy of the practice would be superfluous. When, however, inquiry is made as to the why of two-stage compression there seems to be still something to be said, or, rather, reiterated, concerning certain of the conditions involved which are too often forgotten or ignored, even when they are not entirely misunderstood.

The advantage of two-stage compression is, of course, the stages, and a two-stage compressor without an intercooler would be an absurdity. The customary enumeration of the advantages of two-stage compression, the

WEIGHT OF AQUEOUS VAPOR, POUNDS IN 1000 CU. FT. OF AIR AT VARIOUS TEMPERATURES WHEN SATURATED WITH MOISTURE

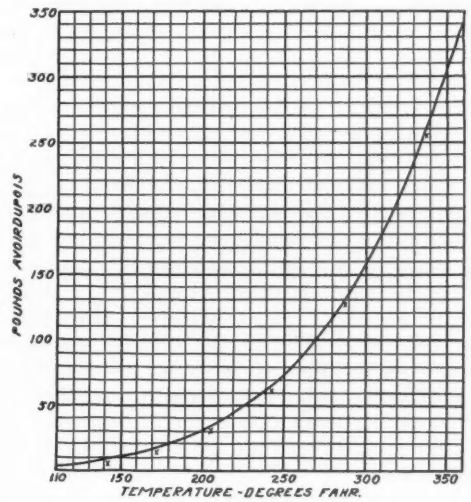
Temp. Deg. F.		1	2	3	4	5	6	7	8	9
0	.070	.072	.075	.079	.083	.087	.091	.096	.101	.106
10	.111	.117	.122	.127	.134	.141	.147	.154	.161	.169
20	.176	.185	.193	.202	.212	.222	.232	.242	.253	.264
30	.276	.289	.302	.313	.325	.338	.351	.364	.378	.392
40	.407	.422	.439	.454	.471	.488	.506	.524	.543	.562
50	.582	.603	.624	.647	.666	.693	.717	.741	.767	.793
60	.821	.848	.877	.907	.937	.969	1.001	1.034	1.068	1.104
70	1.140	1.177	1.215	1.256	1.295	1.337	1.379	1.423	1.468	1.514
80	1.562	1.612	1.661	1.712	1.765	1.819	1.875	1.932	1.991	2.071
90	2.113	2.176	2.241	2.308	2.376	2.446	2.518	2.592	2.667	2.744
100	2.823	2.905	2.988	3.073	3.161	3.250	3.342	3.436	3.531	3.629

intercooling being assumed, is usually somewhat as follows: The reduction of the volume of the air under compression and the consequent saving in the amount of power required for the subsequent compression of this reduced volume. The avoiding of the high temperatures attained in single-stage compression, thus securing more satisfactory lubrication of the cylinder and piston surfaces of the valves and passages and the accompanying considerably higher speed and thereby the compressing capacity of each individual compressor. The avoidance of the high temperatures also largely prevents the burning of the oil, the deposition of its carbon upon the surfaces of the valves and passages and the accompanying volatilization of the lighter constituents of the same oil and the formation of dangerous explosive mixtures with the air.

These particulars should be quite sufficient to justify the employment of two-stage compression, but the claims are usually carried farther. The use of the intercooler, it is said, helps to extract the moisture from the air so that it is delivered in a drier condition to the drills, or wherever it is finally used. It is this last proposition to which I wish to call attention, offering nothing really new, but still what it may be well to be reminded of.

I may as well say at once that the foregoing is too much to claim for the intercooler. Its use does not warrant any presumption that the air when it comes to do its work will be any drier on account of it. As far as the intercooler is concerned, and ignoring for the moment the arrangements to be subsequently spoken of which may be adopted for taking the moisture out of the air, it may be said that the air will be just as wet as it can be, or completely saturated with moisture, when finally compressed and otherwise ready for use.

Attention is here called to the table, which shows the weight of moisture in saturated air through the entire range of ordinary atmospheric temperatures. It will be seen that the moisture content rises rapidly with the rise of temperature so that at 100 degrees it is 40 times as great as at zero.



VARIATIONS IN WEIGHT OF WATER IN 1000 CU. FT. OF COMPRESSED AIR WITH DIFFERENT TEMPERATURES

The curve applies to the ordinary compressed air conditions, showing the weight of moisture—or let us hereafter frankly say water—contained in 1000 cu. ft. of saturated compressed air at various temperatures. It refers to the actual volume of the air in the compressed condition, the pressure of the air being practically negligible. While the saturated condition rarely occurs in the free air as it is taken into the compressor, it almost invariably is reached before the air after compression is fully restored to normal temperature.

Perhaps the most noticeable feature is the rapidity with which the water capacity increases as the temperature rises. Thus at the lower end of the curve there is an increase of only one pound of water for a temperature rise of 10 deg., while at the upper end of the curve a rise of 10 deg. in the temperature shows an increase of about 40 lb. in the water capacity. The several little crosses, X, marked along the curve, indicate approximately the points at which the water capacity is successively doubled as the temperature rises.

There are various ways of treating the problem of getting the water out of compressed air. I propose here

to take 1000 cu. ft. of free air and to follow it through the successive operations of compressing, intercooling, recompressing, after-cooling and separating or draining, without paying any attention to the isolated strokes or revolutions of the individual machine.

There are thousands of compressors in use with a free air capacity of about 1000 cu. ft. per min. If we take one of these machines and assume for the intake air a temperature of 65 deg. the water content of the air if completely saturated would be almost exactly 1 lb. to the 1000 cu. ft., and if 50 per cent saturated, which we here assume as a fairly average and frequently occurring condition, there will be ½ lb. of water to the 1000 cu. ft. of air.

If we compressed this air by a single compression to, say, eight atmospheres, or 105 lb., gage, the final theoretical temperature would be 500 deg., which in these days is not to be thought of. In two-stage compression to the same pressure, going to three atmospheres, or 30 lb., gage, in the first cylinder, the temperature then reached would be only 262 deg., and the air volume before going to the intercooler would be 460 cu. ft. instead of the original 1000 cu. ft. If after passing through the intercooler, the temperature of the air were reduced to 100 deg., the volume then ready for the second compression would be 356 cu. ft.

Now it is time for us to be looking after the ½ lb. of water with which we started, to see how much of it we will get out of the air at this stage through the beneficent intervention of the intercooler. Referring to the table it will be noted that the weight of water required to saturate 1000 cu. ft. of air at 100 deg. is 2.823 lb., or 0.002,823 per cu. ft. Then 356 cu. ft. × 0.002,823 = 0.974, or very nearly 1 lb., but as we have only ½ lb. it seems quite evident that the air must be in condition to accept additional water rather than to surrender any of what it has. This condition occurs, it is to be remembered, after the cooling function of the intercooler has been completed.

Here we encounter a curious thing. It is undoubtedly a fact, notwithstanding the above, that in many cases the air does give up some of its water, an uncertain and incomputable quantity, while passing through the intercooler, and this water may be drawn off from time to time if the necessary arrangements are provided. This is not as difficult of explanation as would at first appear.

The cooling of the air as it passes through the intercooler is effected not by the gradual and uniform cooling of the entire mass of air at any time present, but by the individual cooling of successive films of air as they come in contact with the cold surfaces of the water tubes. Portions of the water in these films of air, as they are cooled down below the dew point by the contact, are condensed at once, and they wet and cling to the cold surfaces and trickle down drop by drop to the lowest to be found, while much of the air is still too warm to release any of its water in this way. Getting any water out of the air in a case such as we are considering is thus an operation which carries with it little guarantee of success, and whatever we might get should be accepted with thanks, "and no questions asked." If little water is obtained, the intercooler should not be blamed for inefficiency in not delivering what it cannot.

Our intercooler having done its good work of reducing the temperature of the air from 262 to 100 deg., and the volume from 460 to 356 cu. ft., the latter volume of air, carrying all of its original content of ½ lb. of water is now ready for the second compression from three to eight atmospheres. When the air is compressed to and ready for delivery at this pressure, and before any cooling, the theoretical temperature will be 284 deg. and the volume 177 cu. ft. At this temperature the air, if saturated with water, would carry 0.125 lb. (⅛ lb.) per cu. ft., and therefore the 177 cu. ft. would require 22 lb. of water to saturate it.

If this air, still retaining its full pressure of eight atmospheres, can be brought down to its original temperature of 65 deg., a great transformation will occur as to its water carrying capacity. The volume will be reduced from 177 to 125 cu. ft. (⅛ of 1000 cu. ft.) so that ⅛ lb. of water will completely saturate it, and then the other ⅜ (of our original ½ lb.) of it will be unable to carry any longer, in the same condition as before.

The concluding phrase of the preceding sentence suggests an opportunity for calling attention to a quite prevalent misunderstanding of the topic we are here discussing. The water which normally is carried by the air is, up to the point of saturation, a perfectly invisible vapor. The moment that the saturation point is reached the excess of water is condensed into minute globules of actual liquid water distributed all through the air and forming a fog. The water is not precipitated, but remains suspended in and distributed through the air until more effective means are provided for its removal.

The call for the aftercooler is evident enough, but it alone is not sufficient. We have not only to cool the air completely and thereby condense and release the water that is more than sufficient to saturate this water and get it out of and entirely away from the air, and these two functions cannot be combined with complete success in any single device. The separation of the water from the air could at best be only partly done in and by the intercooling, because the air would not be completely cooled and its excess of moisture completely condensed and ready to be separated until the instant of leaving, so that a supplementary separator would be required in any case.

This is the precise time when the separation of the water from the air should be effected, the pressure being at its highest and the temperature at the lowest, both conditions co-operating to minimize the water capacity of the air. The actual operation of separation is precisely the same as the separation of water from "wet" steam, and a bona fide steam separator is an effective arrangement for the purpose.

If the air is conveyed a long distance through pipes of liberal capacity these will serve as a separator and the air will be drained of its water automatically. The air as it flows along will roll over and over more or less and the free water will wet the pipe surface and then be carried along as a flowing stream at the bottom. It is quite necessary that pockets be provided at the low points for the water to accumulate and be drawn off from time to time. A receiver at the farther end of the line will take the last of the water obtainable. The ideal condition would be reached if some means of treating the air could be provided here and then the remainder of water in the air would never be heard from.

Patching Boiler Settings with Plastic Cement

ONE OF THE most effective things done to increase the efficiency of my boiler was to fill all the cracks in the boiler setting with plastic cement, and where the cracks were very large or a brick was fallen out, the hole was filled with a thick mixture of plastic cement and mineral wool.

All cracks such as the outlines of iron work, of the cleanout-door and boiler front were well filled with plastic cement. The holes in the settings where the blowdown, blowoff, feed pipes, etc., enter the settings

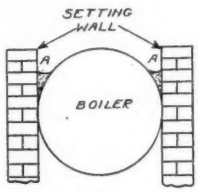


FIG. 1

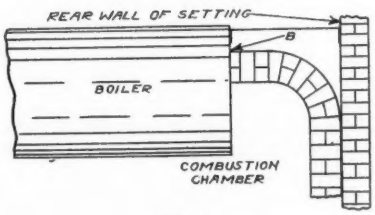


FIG. 2

FIG. 1. USE OF PLASTIC CEMENT BETWEEN BOILER SHELL AND SETTING

FIG. 2. JOINT BETWEEN REAR ARCH AND BOILER SEALED WITH PLASTIC CEMENT

were filled with a very thick mixture so that the heat will not soften the cement before it sets. After this was done I noticed that I had a much better draft, which meant better combustion and cleaner flues.

Then one day my arch over the fire doors fell down and left a hole large enough to let a brick fall through on its flat side. This being a very busy day, I could not keep up steam, so I tried plastic cement and mineral wool in the following manner.

I cleaned all the remaining brick of their soot and ashes, and with an old paint brush I painted the cleaned brick all around the hole to be patched, thus making a good adhesive surface for the patch. Then I laid a piece of stiff asbestos paper across the hole and applied a 1-in. coat of loose mineral wool over the paper, then a very thick mixture of plastic cement and mineral wool. The heat then softened the binder and allowed the free mineral wool that was applied on the paper to become saturated with a good binder that later dried and made a splendid bridge and protected from the heat the top part of the patch, which remains soft, pliable and airtight.

A patch of this description has been in service for about 5 mo. and is still in good condition, having saved a cutout boiler with all of the involved losses. Similar repairs have been made when the fire has destroyed the brick, and they all hold good.

Another splendid place for it is in the V shaped joint, where the boiler shell meets the setting as shown at A in the sketch. When repairing or building, the space A should be filled a few inches with loose mineral wool, then a coat of thick mixture of mineral wool and plastic cement. The cement binds the loose wool together, protecting the top from the heat, and allowing the top part to adhere to the boiler on one side, and the setting on the other, thus making an airtight joint, yet plastic enough to allow the boiler to expand freely.

This soft cement on top will catch any small, loose particles of mortar or brick that are always dropping off in the place mentioned, and prevents them from falling down in the bottom of the V shape when the boiler is cooled, and causing the walls to be pushed farther apart at the next heating.

The V shape may be filled with a coat of cement and a coat of dry wool alternately, each an inch thick for about 7 in.

You can apply this mixture to the rear end where the setting meets the boiler above the flues in the combustion chamber, as shown at B in the sketch. This has caused me much trouble and the company much fuel.

C. F. PYE.

Hydrostatic Test

WHILE a hydrostatic test is generally demanded of the owners by boiler laws and official rules and regulations, it does not thereafter follow that the boiler will be safe even though it has stood such test. The chief or main value of a hydrostatic test is that it shows leaks and in no case should the test be such as to strain the parts of the boiler beyond the elastic limit of the material in the boiler.

In applying the test raise the safety valve or leave a vent for the air to escape from the boiler. After the boiler is filled, close all outlets and block the safety valves. Pressure must then be pumped up very slowly at the same time watching for any sudden drop of pressure which signifies a sudden yield or giving of some part of the boiler. When the desired pressure is attained, mark up all leaks about the boiler. Then relieve

some of the pressure by opening a valve or cock and start calking up the leaks. If the test is applied in cold weather, heat the water to a lukewarm temperature if possible.

Taking boilers in battery for test, it is necessary to blank the main steam line and not rely upon the stop valve. Test the steam gage before applying the hydrostatic test and if found incorrect, correct it at once.

To demonstrate the value of the hydrostatic test, I will relate a little instance that happened during the month of March, 1922. The insurance inspector inspected a boiler on Feb. 26, 1922, and reported it safe and in good condition to operate at 125 lb. pressure. The examination was not hydrostatic, but ocular and by the hammer test (very little hammer test). About 20 days afterwards, the boiler was brought into the shop for a new set of flues. Upon examination and hydrostatic test, the following defects were found; this was a vertical tubular type: 6 in. mud on mud ring inside of boiler, also heavy scale and mud on flue sheet; no heads on 16 rivets at mud ring—wasted away; no calking edge—wasted away; three cracks in upper flue sheet between flues; side sheets outside wasted from a thickness of 3/8 in. down to 1/16 in.; serious pitting at mud ring both inside and outside; cast-iron mud ring cracked in three places.

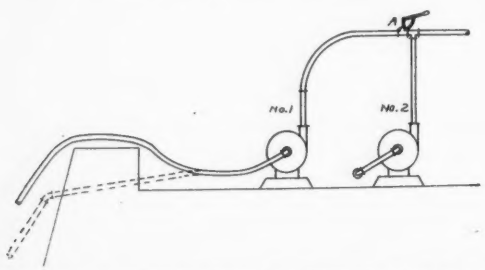
Now, by an ocular and hammer test, it would not show up some of these defects and some it would; but evidently the inspector did very little looking around, for certainly some of these defects were easy to locate. But with pressure down, he could not locate the cracked mud ring or flue sheet bridges.

It will be ascertained that the hydrostatic pressure's greatest enemy is the traveling inspector who does not want to be bothered with carrying the outfit for making such test; but if I were the owner, I would demand a hydrostatic test annually. C. W. Carter, Jr.

Unusual Pipe Trouble

In a mill we had two 4-in. centrifugal pumps, one running continuously, the other as an emergency which sometimes had to be run to help out in a peak.

Referring to the sketch, you will see that both pumps discharged into the same line, but each had its own



ORIGINAL AND REVISED PIPING OF CENTRIFUGAL PUMPS

intake line. No. 1 gave trouble in starting. Although each pump could be primed with the gland water line, we could not fill the pipe entirely on account of a rise in the line which formed an air pocket; at times it worked, but when badly needed it did not. After we relaid the pipe in straight line by cutting through a retaining wall, that trouble was over.

In the discharge line at A was a quick action lever gate valve which leaked badly and the operator used to hammer the gate down to seat and to open it hammered the handle up.

One day he had to cut in No. 1 with No. 2 and after running a while there was no water pumped, valves were open, the motor was pulling load, the packing gland leaked little more than usual. The runner was on the shaft, as we could hear the churning inside. The casing did not heat; it could hardly heat with the independent gland water and the leaks, so we were puzzled. A thorough examination showed there was nothing wrong with the pump, still there was no water pumped up. The idea came to open the cover of the valve A and see if anything had stopped there. We soon learned the cause of all; the threads of the gate handle were stripped and the pin had been sheared off by repeated hammering. A new gate and stem were put in and everything went fine. Chas. Labbe.

Babbiting Loose Pulleys

Considerably different arrangements are required for babbiting loose pulleys while they are on the shaft from those needed when the pulley is off the shaft but

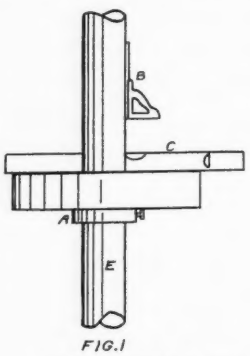


FIG. 1

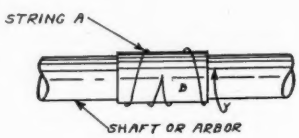


FIG. 2

FIG. 1. PULLEY PLACED ON ARBOR FOR BABBITING
FIG. 2. METHOD OF FASTENING PAPER TO ARBOR

the fundamentals are practically the same. In case it is to be babbited off the shaft and an arbor is to be used, the arbor should be held in a perfectly upright position, then a collar should be put on at A, Fig. 1, so the pulley can rest upon it by its hub; then use a level across the rims as in C, Fig. 1, trying it at cross angles. Now the pulley can be centered by measuring from the outer edge of pulley rim to arbor all around. To prevent babbit leaking out, putty or cardboard should be put on top of collar A, setting the pulley on it; all oil holes should be plugged to the shaft or arbor with dry pine plugs.

It is a good plan to cover the shaft or arbor with oily paper; fasten it by tying string about 1/16 in. diameter as shown in Fig. 2, which will make oil grooves in the babbit, the groove inclining to the center from each end of box. This will carry the oil to the center of the bearing and give a better distribution.

If the job can be done on the shaft, a plumb-line should be dropped down by the tight pulley and if found to be plumb and to run true, the loose pulley can be set in position for babbiting by the tight pulley. It will be found necessary to drill an extra hole through the hub and this can remain filled with babbit and the oil holes will not have to be drilled out, but simply

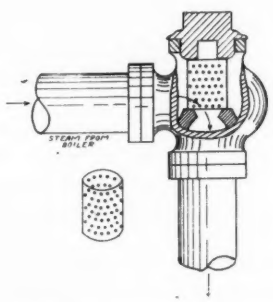
take out the pine plugs and put in oil cups. It should not be forgotten that the casings of the boxes must be roughened or chipped so that the babbit would not turn in the shells; for a sure job the boxes should be heated especially in winter.

To those who would like to mix their own babbit I give my formula: For fast running machinery and hard service use, tin 72, copper 10, antimony 18 parts; for ordinary bearings, zinc 20, antimony 48, lead 32. The zinc is melted first, then added to the others. There are many formulas to be found in standard works on babbiting and many of them give excellent service with proper care. SAM BOWE.

Straining Steam to Injector

ON REPLACING one of the steam pipes leading from the dome to the injector, it was necessary to use a piece of galvanized stock as the size could not be obtained in the black. On the second day after it was placed in, the injector began to bother and acted as if it was not receiving the necessary pressure of steam. On examination it was found that small zinc scales had accumulated at the small opening at the top of the injector, shutting off the required pressure for operation. These were cleaned out, but within an hour the same trouble was renewed.

To save continuous cleanings after it was discovered that the zinc scales were from a poor job of galvanizing, the pipe was removed and cleaned; but it did not remedy the trouble for long. A single scale would lie on top of the small opening to the injector and could be removed only by shutting off the steam and removing the injector. To tide over the time it was necessary to use the defective piece of pipe I took from the tool box



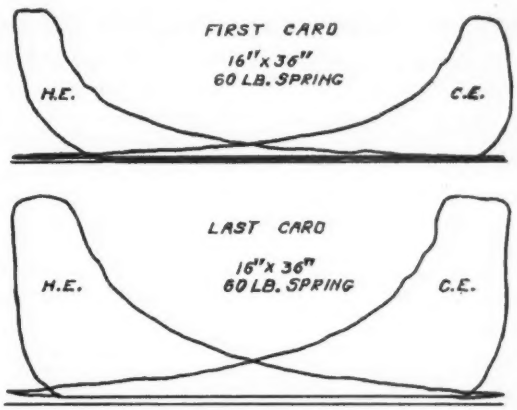
STRAINER IN STEAM CONNECTION TO INJECTOR

an old ell check valve and placed it where a malleable ell formed a part of the steam line between the defective pipe and the injector. Removing the check from the valve, I substituted in its place a screen made by punching small holes through a piece of tomato can tin and after cutting it to proper height so that the valve cap could clamp it to place, formed it into a cylinder, lapped the joint and placed it in the check valve chamber. This stopped the injector trouble until the defective pipe was forgotten about.

About a year later the same trouble was renewed, but no scale was found on the injector. Removing the cap of the valve, it was found that the space about the screen was packed solid with the zinc scales. These were cleaned out and the changing of the pipe is yet undone, the screen service overlapping the cleaning jobs to such an extent that each time it is forgotten or neglected when repair time arrives. G. G. MCVICKER.

Diagrams from 14-Year-Old Engine

THE ACCOMPANYING pair of indicator diagrams are from a 16 by 36-in. Murray girder type single eccentric engine, which has seen a 24-hr.-a-day service for about 14 yr. During that time, it has run almost continuously



FIRST AND LAST INDICATOR DIAGRAMS FROM CORLISS ENGINE 14-YR. OLD

with but little expense for upkeep. The valves now need attention, as they are worn considerably, the exhaust valves especially.

These are the first and last cards taken; the load was heavier on the last card. TOM JONES.

Drill Twists

WHEN USING a post drill, or other heavy drill, it is frequently well, if the metal drilled is very hard, to adjust so that the drop of the bit will not be too fast. If your machine has no such adjustment, do the best you can without it, but it is well not to try to go too fast in such a case. This is an instance of "The more haste the less speed."

When you have a breast drill, it is best to work either straight down on the work, or with it set straight before you. You will find that it makes the work easier and produces a neater job than any other way.

If you have to drill pipe, work so as to drill it radially if possible. If it is impossible to drill radially, you are just "out of luck." In such a case I should clamp the piece tightly in place, secure several extra drill bits, lower the first bit till it almost touched the work, and begin very slowly. In any case, do not try to drill both sides of a pipe at one time. It is better to withdraw the drill when the first hole is made and turn the pipe over.

If your machine has no device for automatic oiling, it is a good thing to watch carefully and oil frequently. It is better to waste oil than drill bits. It is cheaper.

Use as short a bit as you can. Besides being easier to handle, the short bit is less liable to break. When you have to drill a deep hole, start it with a short bit, and use a longer one afterward.

Temper your speed with common sense. You will get through almost as soon if you do, and there will be

a much neater piece of work as a result. Besides this, it takes time to change drill bits, which has to be done pretty frequently with high speed work. I once saw one of the "speed fiends" break two drills in as many minutes trying to drill through a quarter-inch piece of steel. The only other bit available at the time was 2 ft. long, and after 2 min. of very slow work he broke it, too. I don't know whether he ever finished the job or not.

GEO. SWETNAM.

Buying vs. Making Your Own Belt Dressings

RECENTLY a mechanic stated that "In the old days mechanics were in the habit of making their own glues, cement, belt dressings, etc." He went on, however, and said that times have changed and as a result, today a great many of our mechanics do not do any mixing at all, but buy factory-made preparations.

Continuing, and according to my viewpoint, he inconsistently said:

"Personally I make nothing but belt dressings. For leather belting I use, by weight, two parts of beef tallow and one part codliver oil. First melt the tallow and allow it to cool until it is little better than lukewarm, then the codliver oil is thoroughly stirred into it."

He also gave a recipe for rubber belts, which involves red lead, black lead, French yellow and litharge, not to mention boiled linseed oil and japan, etc.

In view of the ingredients used by the above-mentioned mechanic, the writer is convinced that it would be much better if he would refrain from mixing his own belt dressings also, and purchase a good reliable manufactured dressing. These dressings do not contain substances that have proven to be actually harmful to belts, such as tallow, boiled linseed oil, litharge, etc.

There are concerns in the United States which have spent a great deal of time and money in the development of belt dressings for all kinds of belts and it is but natural that they should know more about belt dressings than a person who has not made the subject his life study. Dressings should preserve and benefit the belt. The elimination of slip is only one of the results sought in a first-class belt dressing.

The writer does not manufacture dressings, but has had considerable experience with dressings, both "home-made" and factory made and he has come to the conclusion that it pays in the end to buy the best dressing on the market.

W. F. SCHAPHORST.

Has Anyone Beaten This Record?

IT BECAME necessary to have a new commutator built for a 100-kw. generator. This generator is a relief machine for a 500-kw. unit.

During the time the work was being done it was necessary to run the 500-kw. unit continuously without closing the throttle on the engine.

This engine is a Filer & Stowell right-hand machine, heavy duty type, cylinder 26 by 42 in., running at 100 r.p.m. and has an 18-ft. 30-T. balance wheel.

The engine was started Jan. 3 at 5 a. m. and ran until May 25. It was stopped at 3:35 p. m. on this date.

It was so operated that it ran just as quietly the last day as it did the first and it was not necessary to make a single adjustment and will not be for some time to come.

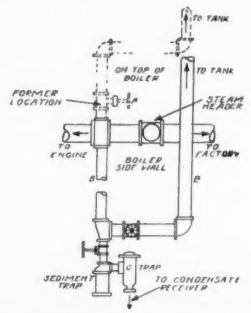
The job of cleaning it up was the worst; we looked like chimney sweeps when we got done.

OAKS KYGER.

Locating Steam Valve for Convenience

IN MY PLANT there are two hot-water tanks where the water is heated by exhaust steam from the engine and other steam-using apparatus, but frequently it is necessary to use live steam to heat the water to the required temperature, when there is not sufficient exhaust steam, as the hot water in the factory used must always be at a certain temperature.

The valve controlling the live steam to the tanks was located on top of the boiler as shown in sketch at A,



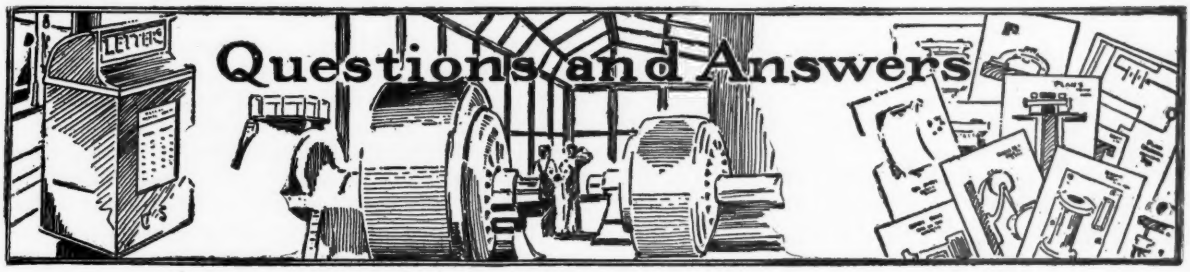
STEAM PIPING ARRANGEMENT SHOWING FORMER LOCATION

when I took charge of the plant. Whenever necessary to turn live steam into the tanks, one had to climb on top of the boiler a number of times during the day. To eliminate this trouble, I changed this by disconnecting the pipe and valve leading to the tank on top of the boiler, turned the tee in the main steam header so it was facing down, then run the steam pipe down the side of the boiler wall to a point so the steam valve could easily be reached from the boiler room floor, then up to the tanks as shown at B. As the pipe from the steam header to the valve was quite long, there was more or less water hemmed in it, more whenever the valve was opened. To eliminate this, I placed a small steam trap at the bottom of the pipe as shown at C, which kept the pipe clear of condensation at all times. The condensate from the trap was discharged into the receiver of condensate from the heating system and other steam-using apparatus, hence this condensation was not lost.

H. A. JAHNKE.

SALES OF fabricated structural steel during May amounted to 82 per cent of fabricating capacity, according to reports made to the Department of Commerce by firms comprising 70 per cent of the fabricating capacity of the United States. The May business reported by 82 firms, having a capacity of 130,600 T., totaled 106,620 T. as against April sales of these same firms amounting to 121,211 T., or at the rate of 93 per cent of capacity.

Total sales throughout the United States, based on the reported percentage and a total capacity of 180,000 T., amounted to 146,900 T. in May, while revised figures for April give a total of 165,900 T. The April figures are based on reports from 87 firms, having a total capacity of 132,600 T., whose sales amounted to 122,198 T., or at the rate of 92 per cent of capacity.



How Should This Plant Be Started?

I WOULD appreciate having the opinion of the readers of Power Plant Engineering as to the best method of starting up a plant such as the one in which I am employed. The installation consists of three 625-kv.a. turbo-generators, one motor and one steam driven exciter unit. The switchboard is equipped for remote control. T. F.

Determination of Furnace Radiation Losses

YOUR CORRESPONDENT C. P. D. asks in the May 1 issue what the heat losses through uninsulated furnace walls are, and what percentage of the fuel fired is wasted to make up this loss.

Exact figures on heat losses are practically impossible to determine by calculation even when assuming that these losses are directly proportional to the conductivity of the wall. The heat flow not only varies with the temperature of the wall components, but is dependent also on

1. Variation in inside temperature.
2. Variation in outside temperature.
3. Thickness of joints.
4. Freedom from cracks in wall.
5. Stability of insulation (if used).
6. Color of outside of wall.

Since the heat loss is governed by temperatures and character of components of the wall rather than being predicted on a basis of operation at certain percentages of rating, it seems that the latter offers no definite fundamental on which to base a calculation.

An approximate estimate, however, of combined losses due to radiation, conduction and convection, expressed in B.t.u. per sq. ft. per hr., can be determined by assuming an arbitrary average temperature for each component of the wall and applying the conductivity of the component at that temperature in the equation

$$Q = t \div (T \div K + T_1 \div K_1 + T_2 \div K_2)$$

Q = B.t.u. loss through wall per sq. ft. per hr.
t = Difference in temperature (deg. F.) between inside of furnace and room temperature (latter assumed at 100 deg. F.).
T = Thickness of fire brick.
T_1 = Thickness of red brick.
T_2 = Thickness of insulating brick.
K = Conductivity constant for fire brick (7.9).
K_1 = Conductivity constant for red brick (7.2).
K_2 = Conductivity constant for insulating brick (0.84).

The conductivity constants given above in parenthesis are those for 1000 deg. F. as shown in the curves Figs. 1 and 2. These curves are averages, being plotted from a series of tests conducted by the U. S. Bureau of Standards.

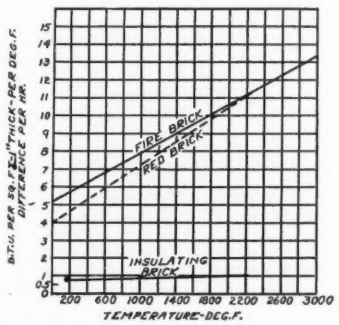

B.T.U. PER SQ. FT. 1" THICK PER DEG. F. DIFFERENCE PER HR.
FIRE BRICK
RED BRICK
INSULATING BRICK
200 600 1000 1400 1800 2200 2600 3000
TEMPERATURE-DEG.F.

FIG. 1. THERMAL CONDUCTIVITY OF AVERAGE FIRE BRICK, RED BRICK, AND INSULATING BRICK AT VARIOUS FURNACE TEMPERATURES

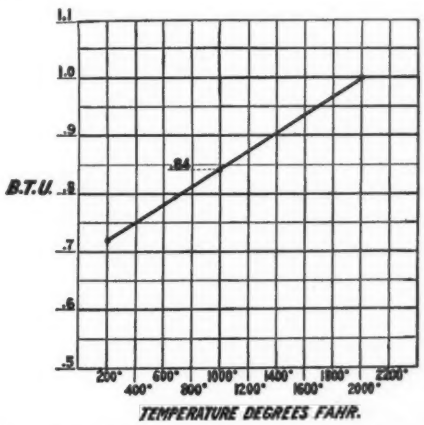


FIG. 2. CONDUCTIVITY OF INSULATING BRICK IN B.T.U. PER SQ. FT., 1-IN. THICK PER DEG. F. DIFFERENCE IN TEMPERATURE PER HR.

Since the inside temperature of a boiler setting wall varies between say 3000 deg. F. in the combustion chamber, to say 500 deg. F. at the flue, it is plain that the conductivities of components of the walls will also change, decreasing with diminishing temperature.

An accurate series of calculations based on the two factors of diminishing temperature in the setting and the temperature gradient through the wall becomes so involved and at the same time so uncertain that it may be abandoned.

A calculation may reasonably be based on an average temperature of 1000 deg. F. as applying to conductivity constants of all components. On this basis, taking the wall mentioned by your correspondent (wall E, Fig. 3), and assuming an average inside temperature of 1400 deg. F., we apply the formula given as follows:

$$Q = 1300 \div (9 \div 7.9 + 8 \div 7.2) =$$
578 B.t.u. per sq. ft. per hr.

Assuming that the boiler setting has 800 sq. ft. of wall surface and operates 24 hr. a day for 300 days in the year, on coal of 14,000 B.t.u. content, the annual fuel loss in tons of coal will be

$$578 \times 800 \times 24 \times 300 \div (14{,}000 \times 2000) = 119 \text{ T.}$$

Expressed in gallons of fuel oil (140,000 B.t.u. per gal.) the loss would be 23,780 gal. oil per yr.

While such loss cannot be eliminated, it can be reduced. It is generally accepted that from 50 to 80 per cent of heat loss through furnace walls can be saved by insulation, depending on conditions, materials used and how applied.

By substituting insulating brick for red brick as in wall H (Fig. 4), the heat loss is expressed as follows:

$$Q = 1300 \div (9 \div 7.9 + 9 \div 0.84) =$$
110 B.t.u. per sq. ft. per hr.

The preventable loss in this case would then be,

$$(578 - 110) \times 800 \times 24 \times 300 \div (14{,}000 \times 2{,}000) = 96 \text{ T. coal per yr.}$$

Using another combination of components, e.g., fire brick 9 in., insulating brick 4½ in., red brick 4 in., the formula reads:

$$Q = 1300 \div (9 \div 7.9 + 4\tfrac{1}{2} \div .84 + 4 \div 7.2) =$$
184 B.t.u. per sq. ft. per hr.

A review of many heat balance sheets shows stated radiation losses as high as 10 per cent, and as low as 2 per cent—the latter representing ideal conditions.

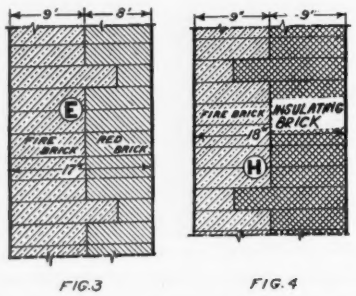


FIG. 3 FIG. 4

FIG. 3. FIRE AND RED BRICK FURNACE WALL
FIG. 4. FIRE AND INSULATING BRICK FURNACE WALL

What concerns the engineer is the preventable loss, and this, for uninsulated walls, is from 50 to 80 per cent. The two cases of insulated walls cited show a reduction in heat loss of 81 to 68 per cent respectively, as compared with the uninsulated wall Fig. 3.

H. T. M.

Corliss Valve Setting

How should we proceed to set the valves on a Corliss engine? C. S.

A. There are, of course, many different methods that may be employed for setting the valves of a Corliss engine, any one of which is probably as good as another. The following directions are simple and have been used with success:

1. Remove the steam and exhaust bonnets and upon the end of the valve there will be found a mark corresponding to the opening edge of the port. The direction of motion for opening the valve may be determined by working the wristplate by hand.

2. Examine the wristplate hub and bracket. Upon the bracket will be found a mark corresponding to the central position of the wristplate and two others locating the extreme travel of the wristplates in either direction.

3. See that the rocker arm travels an equal distance each side of the vertical position. To do this loosen the eccentric and rotate it slowly about the shaft. With a plumb bob and scale measure the distance the rocker arm travels each side of its central position; adjust the length of the eccentric rod to make the distance equal.

4. Rotate the eccentric about the shaft and see if the wristplate travels equal distances on each side of the central position. If it does not, adjust the length of the hook rod to make the travel equal.

5. Block the wristplate in its central position, then pull up the dashpot rods until the hook pin engages with the steam hooks. Adjust the length of the steam and exhaust radius rods until the valves have the proper amount of lap.

6. Throw the wristplate first to one, then to the other extreme position and adjust the length of the dashpot rods so that the steam hooks will latch with the hook pins when the wristplate is at its extreme travel, allowing, of course, for clearance.

7. Place the engine on dead center and see that the hook rod is fastened to the wristplate. The eccentric should then be turned in the direction the engine is to run until the proper amount of lead is secured, fasten the eccentric to the shaft and place the engine on the opposite dead center and measure the lead. If it is not the same, make it the same by adjusting the length of the steam radius rods.

8. Block the governor in the running position and fasten the reach rod lever at right angles to a line drawn half way between the two rods. Adjust the length of the reach rods until the knockoff arm stands vertical; with the governor in this position turn the engine over until cutoff occurs, and then measure the distance the crosshead has traveled; place the engine in the same position on the back stroke and adjust the length of the valve rod until the cutoff occurs. This will give equal cutoff at each end of the cylinder for this governor position.

9. Drop the governor to its lowest position and see that the safety chips on the knockoff levers are adjusted so as to prevent the steam hook from latching with the hook pin.

Cause of Leakage of Pipe Joints

In the June 1 issue, O. L. W. writes of having trouble with gaskets. As the plant has a capacity of 2500 kw., his steam pressure will probably be high, and extra heavy pipe and fittings will be employed. He does not say what kind of material composes the gaskets. There are several high pressure sheet packings on the market, and also several makes of metal gaskets, corrugated copper, a combination asbestos and corrugated copper, copper with asbestos inside, etc. These gaskets usually fit within the bolt circle.

If the bolts are pulled up tightly, pulling on one nut after another, and going around several times, the joint ought to be steam tight, and not give trouble afterwards, unless, of course, the faces of the flanges do not line up properly. Perhaps there is a strain on the

pipe line caused by expansion, which may cause the gaskets to leak, or perhaps the gasket material is not adapted for the pressure. I would advise O. L. W. to write to some firm making a high pressure gasket and ask for one to try out, at the most bothersome joint.

TOM JONES.

Chattering Non-Return Valves

IN THE March 1 issue of Power Plant Engineering R. K. asks for an opinion as to the cause of chattering in non-return valves, but does not give the make or type of valve, which should be known before a comprehensive answer can be given.

I have found various kinds, shapes and sizes of these valves that were made wrong and gave poor service or annoyance. Some broke, some stuck open with grit, rust and mud, and some chattered. I believe that if manufacturers would follow up their products and find out what engineers think of these things and be governed by their experiences, every one would be benefited. Mr. Roe says he had a neat-fitting ring put on the piston of his valve and stopped the chatter. No doubt of it.

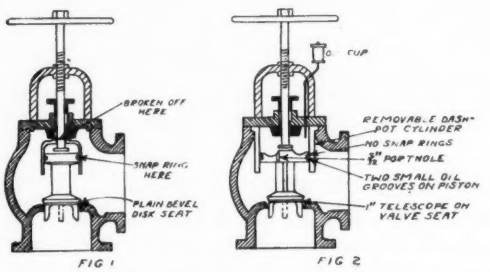


FIG. 1. ORIGINAL VALVE SHOWING BREAK IN DASH POT CYLINDER

FIG. 2. VALVE AFTER REPAIRING SHOWING NEW METHOD OF CONSTRUCTION

Suppose this valve ring is 8 in. in diameter, 1 in. in width and the boiler pressure 150 lb. The area of the seat, 28 sq. in. multiplied by 150 lb. equals 4200 lb. pressure on inner side holding this ring against the unlubricated walls of the dashpot cylinder. That is sufficient to stop the chatter and also the non-return feature.

I always remove these rings from the piston even if I put on a new valve so fitted. The groove should be filled in and turned to an easy sliding fit. Drill a 5/32 port hole through the piston and if then the valve chatters have a new piston and valve seat made as shown in Fig. 2.

Drill and tap the valve cover to receive a small cylinder oil cup and fill this cup with good cylinder oil once a week.

The whole story of preventing chattering simply is that the dashpot piston must not be too loose, the vent port not too large and the disc of the valve should telescope the seat at least 1 in.

I once returned a 6-in. valve to the maker for refitting. It came back with a tight-fitting ring and a ½-in. port hole through the piston. I suggested to the chief that I remove the ring, and he in turn suggested that the makers ought to know more about it than we did and for me to leave it in. I therefore obeyed orders and struck a compromise all off to myself by taking a small peen hammer and closing the ring until it could not touch the cylinder wall. I then reduced the ½-in. hole to 3/16 in. and put an oil cup on, and the valve worked fine.

Recently I went into a plant fitted with eight old type valves. Some were broken and the parts loose in the body. The defects in the design were plain to be seen. The valve had stuck open and plugged with mud carried over from boilers and when it was forced shut by the hand wheel, the dashpot broke as shown at Fig. 1.

The sketches show the valves before and after repairing.

CHARLES B. RISLEY.

Leaky Tubes Caused by Scale Accumulation

THE DISCUSSION which has been taking place concerning the cause of leaky tubes seems to me to be altogether too superficial; the effect rather than the cause has been discussed.

The same question might be asked as to what causes the tubes to buckle. The cause is the same in both cases, namely, overheating, stretching and burning out of the tubes, which is invariably due to the scale accumulation.

When the tubes in a water tube boiler are properly rolled and beaded they seldom leak. The leakage occurs only in return tubular boilers. In those boilers the scale accumulation is on the outside of the tube. The overheating causes the tube to stretch as a result of which it either loosens in the header or, if very well rolled, the tube buckles. If it loosens, the scale deposit serves as a patch to cover up the leak and hold the pressure as a result of which the leak is not exposed until the scale falls. It is here that certain mechanical cleaners of the vibratory type designed for return tubular boilers are erroneously blamed for loosening the tube, whereas they have merely removed the scale which was preventing the leakage.

In a water tube boiler, on the other hand, the tubes are securely fastened. There is no scale deposit to press against the header, as the scale is on the inside, consequently the overheating and stretching causes the tube to buckle. Anyone experienced with steam boilers knows that in return tubular boilers the buckling is always downward whereas in water tube boilers it is always upward, this course being due to the location of the scale—in a return tubular boiler on the outside and upper portion of the tube—as a result of which it is the lower portion of the tube that expands and pulls it downward. In a water tube boiler the scale is principally on the inside and bottom wall, and as a result the upper portion expands and pulls the tube upward.

This buckling is frequently experienced even in the Stirling, Badenhausen and other similar types of vertical water tube boilers.

Rerolling and tightening the tubes in the header is merely a temporary remedy and after a number of such rerollings the tube is too thin to hold and the next step, in return tubular boilers, is usually to cut off the tube end and weld on new pieces. The only positive cure is to remove the scale deposit on the heating surfaces and there is no more certain and positive means of doing this than by the use of mechanical cleaners.

C. S. DAVIS.

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Every Engineer a Storekeeper

In every plant it is necessary to have on hand a considerable stock of supplies and repair parts to take care of emergencies, alterations and regular operation. This material represents capital tied up, and therefore a non-productive expense. As in every other business, non-productive capital reduces profits and should be reduced to a minimum.

In retail stores it is found that one of the factors most helpful to success is quick turnover of goods, both because it reduces the money invested in them and because it prevents accumulation of "dead stock." The plant manager is in practically the same position. Keeping the stock of oil, supplies and repair parts down to that actually needed in order to avoid interruption of operation will result in less investment of money, less chance for loss from deterioration or damage of stock, less temptation to wasteful use of supplies, and will give opportunity to change from what has been used, if something better adapted to the needs of the plant comes into the market.

It pays, of course, to buy in large enough quantities to purchase economically, and to keep on hand such material as will avoid delay in making repairs or replacements; but unless the difference in price on a larger quantity is more than sufficient to pay the carrying charges for interest, depreciation and waste, two or three months' supply would seem to be ample at most.

"A penny saved is tuppence earned."

Unjust Discrimination

During the War many things were done that are not justifiable now that peace has returned. Railroads and manufacturing plants were taken over for war work regardless of the interference with regular business or the interests of industry. Taxes were levied to raise money for war work that are not now necessary and would be harmful to prosperity. Men were drafted for military and industrial service who could ill be spared from their regular work. These things were necessary to carry on the war, and no good citizen objected to the hardships that were imposed. But practically all of these emergency measures have been done away with so that industry and individuals may return to a normal way of operating.

Among the taxes that were levied as a war measure was the increase in postage on periodicals which was raised to 325 per cent of the former amount. The bill imposing this tax was passed during the war, but the raise was progressive, so that the full effect did not take place until July 1, 1921, long after the war was over. Every one of the items of war taxes carried by the 1917 bill has been modified or repealed except this excessive tax on periodicals, the postage on which is so high that many periodicals have been driven out of business, many others have been forced to limit their circulation to the nearby territory because of the unreasonable postage rate to distant zones, and others have been driven from the mails as they could get transportation by private agencies for less than the postage cost.

Service to their readers and to the industry which they serve is the primary object of business papers, and any obstruction to the widest usefulness is an injury to the readers and to the industries. Representative M.

Clyde Kelly of Pennsylvania in speaking of a bill which he has recently introduced, which provides for a modification of this war time tax, said: "There is something radically wrong when private companies can make a handsome profit by carrying periodicals at rates less than those charged in postage. Periodicals are the very fountain source of first and fourth class mail. They also carry freely messages of the post office and other departments of the government direct to the people. But they get no commission for this work. Periodicals are information highways, just as essential to the business prosperity of the country as the highways and waterways. Not a sale can be made or a pound of goods shipped without the exchange of information. I believe there is no good reason why the publishers of periodicals should be singled out to pay this extra war tax."

It should be noted that the bill does not provide for a return to prewar rates, but leaves the postage on periodicals still at 175 per cent of those rates, and also retains the zone system of charges. In addition, publishers are subject to all the income and franchise taxes that other business carries so that they are certainly being given no advantage by the modification of the rates to remove the war tax feature.

Furnishing information and assistance to help business and industry is hardly to be classed as a luxury, nor is it an activity whose increase may do harm to the country or to individuals. On what ground should it be singled out for repressive and prohibitory taxation?

Coal Strike Progress

So far as reaching a settlement is concerned, it may as well be admitted that little or no progress has been made. But there are indications that both parties to the controversy are feeling that some action looking toward settlement should be taken.

It is summer, when nobody wants a fire in the house anyway; business has been quiet so that demand of the industries for coal has been likewise; production from mines now operating and drafts from reserve coal stocks have supplied all calls for coal promptly at prices not much out of line with those of past months. So why worry?

But it is time somebody looked ahead. This is the season when stocks of coal, especially in those districts remote from the coal mining regions, should be accumulating instead of diminishing. Bins of domestic users should be filled with the winter's supply. Storage piles for central stations and large plants should be completed. Northern lake docks should be filled. Contracts for the supply needed for next fall's business, which promises to be considerably larger than of last year, should be made. Yet nothing is being or can be done under present conditions.

But one constructive act has so far been performed, and that is in the nature of panic insurance rather than solution of the strike problem. Secretary Hoover's conference to limit price boosting was a wise precaution to prevent gouging by operators and dealers in case shortage becomes acute. It is not an invitation to charge at once the maximum limit set, $3.50 for spot coal, although a few operators and dealers seem so to interpret it. But most far-sighted operators are selling at a reasonable profit above cost of production and will continue to do so. At the price set as maximum, some mines will lose money, some will make a fair profit, some a large profit, and a few whose cost of production is exceptionally low, will get big profits.

The government has no authority to compel compliance. It can use only moral suasion in the effort to protect consumers against extortion in case of shortage. But the consumer can ascertain by inquiry from whom his dealer buys coal; whether the dealer has a contract or what his spot cost is; what the cost of transportation is; and what should be a reasonable charge for handling, delivery and profit. If he believes that he is being treated unfairly, and appeals to the Department of Commerce, the conditions will be looked into and such action taken as the facts warrant.

One other provision looking toward preventing a panic demand is the proposal to select committees of coal operators for each district to stabilize conditions against profiteering, topped by a committee of operators at Washington to act in concert with committees from large coal using industries so as to prevent any attempt to corner the market or overbuy and rob the market.

All this is, however, a temporary expedient to minimize the harm to the public from the strike situation. It brings a settlement no nearer. And it would seem that public sentiment must play a considerable part in bringing operators and operatives to realize that coal for the country's needs must be produced, regardless of private differences. Coal is a fundamental necessity. Without it neither people nor industry can live; and demand for government operation of mines will be justified, much as that course is to be deprecated, if coal can be had in no other way. Then arises the question—what would be a fair basis for operation? Perhaps every reasonable person would agree to the following in principle: Use only as many operatives as is necessary to mine the coal when giving as constant employment as possible. Pay a wage which will under these conditions give a monthly return equivalent to that received by other workers of like skill. Provide for fair return on capital invested and for reasonable profit, taking into account, risk and depletion of the mines. Provide for distributors and retailers a margin to cover cost of transportation, handling and delivery plus fair return on capital and reasonable profit.

These cost items would rightfully be included in price of coal to the consumer, but, under government operation, the public would have to pay for the cost of government supervision, either by adding it to the price of coal or in the form of taxes. That expense would be eliminated under private operation, but the

Power Plant Slogans

Keep and Analyze Operating Records in Every Power Plant.

Develop Water Power Sites.

Promote Health and Safety in Power Plants.

Handle Coal and Ashes Mechanically.

Employ Engineers for Engineering Work.

other items would have to be covered by the price. To determine the reasonable figures entering into this price, it is necessary to have reliable data on output, invested capital, operating cost, transportation and handling costs, all of which are certainly in existence in the records of unions, mine operators and dealers. Data so far made public have come from interested sources and lie open to the suspicion of partisan bias, but give some indication of conditions.

It seems evident that the industry of mining bituminous coal is over-manned. Some idle time is unavoidable due to breakdowns, lack of cars, national holidays and seasonal demand. But, if every miner worked every day that his mine was operating, and idle time due to local disagreements and "voluntary holidays" was eliminated, a large number of men now in the mines could be transferred to other industries, those remaining would get better incomes, all coal needed could be produced, even though some mines might be closed down, and the cost to consumers would be reduced.

Some figures in a report recently made to Congress by a commission on Investments and Profit in Soft Coal Mining indicate that profits of mine operators have been higher than is consistent with public interest. The data available are incomplete; but the fact that during the coal panic of July, 1920, the profits of one group of companies rose to six times what they were a month previous indicates returns greater than needed for the operators and illustrates what Secretary Hoover is attempting to forestall by his present voluntary agreement on a maximum spot price.

Rumors of sales and resales by speculators of coal in transit or on sidings are too frequent to be entirely fiction, and indicate the tendency to boost prices by taking unearned profits when demand for coal temporarily exceeds the supply.

All these are abuses which should be removed from the conduct of the coal industry. Data available to the public are not sufficient for a basis of sound judgment as to what is fair to all parties, and those having such data have been unwilling that such information be made available. If those in the coal industry, operators, operatives and distributors will not recognize that the interests of the ninety-nine and a half million of people who are consumers of this vital necessity are of greater consequence than the self-seeking of the half-million who are working in the industry, and will not set about bringing the operation of that industry in line with the interests of the vast majority, government, on behalf of all the people, must step in and take control by regulation. And if agreement to go to work mining coal cannot soon be reached, government should step in and take control of operation while a method for regulation of private operation is being worked out. Unless production is started almost at once, there is bound to be acute fuel shortage next winter, with possible return to the zoning conditions of past war-time winters, and rationing of coal to essential industries. There remain but three months in which to stock up for the winter. The strike is still on; reserves are being used up, and there is no sign of getting back to digging coal. It is high time that consumers awake to the conditions, the prospect ahead, and the importance of public sentiment demanding that definite progress be made toward getting coal out of the ground.

American Engineering Council

MUCH important work was accomplished at the recent meeting of the Executive Board in Pittsburgh, in final decision reached and new work started.

Registration of engineers, which has been under discussion for a considerable time, was disposed of by recommendation that licensing or registration cover engineers having responsibilities for public works, that mining engineers be not included in registration and it is an open question whether other classes of engineers should be. Reciprocity as between states should be provided in any plan for licensing or registration.

Employment service which has been operated by the council will be turned over to the four founder engineering societies by whom it was originally started, as it is felt that this is a personal service to members, while the province of the council is activities having to do with public welfare; but study is to be continued of some plan for co-operation of all engineering employment agencies.

Plans for conservation of forests and water powers have been worked out and are to be presented to President Harding by the proper committees, with co-operation of other groups.

Support of the President was pledged in the plans for reorganization of government departments on a more efficient basis, with provision for a movement to establish a Department of Public Works for re-allocation of all engineering and public works functions of the government to one department.

For continuous industries, the question of two 12-hr. shifts against three 8-hr. shifts has been under investigation by a committee which has gathered a great mass of data. Immediate interest centers on the steel industry, and investigation is under way of the engineering requirements of metallurgy and production if three shifts are used instead of two. The committee is at work putting the report of the investigation into shape for presentation to the next meeting of the board. Bradley Stoughton, formerly secretary of the mining engineers, was approved as director of the field study.

President M. E. Cooley reported plans under way for bringing all associations of professional engineers into the federation, so as to have a unified force ready to serve the nation in all matters affecting public interest into which engineering enters. He stated also that committees are at work on a policy of affiliation of American engineers with those of all other nations, through their engineering associations, and that a movement is on foot, headed in London by Sir Robert Hadfield, to form a union of engineers of all English-speaking countries.

Other subjects discussed were the report on cycles of business depression, jurisdictional awards in labor disputes, patent legislation and aero research.

The board expressed its appreciation of the hospitality of the Engineering Society of Western Pennsylvania by whom it was entertained, and adjourned to meet in Boston in the fall on a date to be fixed by the Committee on Procedure.

IF YOU want knowledge, you must toil for it, and if pleasure, you must toil for it.

New Type Emergency Closing Valve

FOR the protection of both boilers and turbines, a new type of cushioned emergency closing trip valve has recently been developed by Schutte & Koerting Co., and installed in some of the large central station, lighting, and electric railway companies. The valve, which is of the balanced combined trip and throttle type, is shown in the open position in Fig. 1, and consists of a globe body having a disc connected to a non-rotating spindle which in turn is suitably connected to a rotating spindle having a spindle thread. This thread engages with a nut that is free to slide in the yoke end or arch. Pivoted about a stationary fulcrum on the yoke is a lever, of which the shorter arm is connected to the yoke by means of a spring, and the longer arm is arranged to engage in a hook controlled by the tripping mechanism. This longer arm of the lever is known as the latching up lever, and is connected by means of pivots to the sliding nut mentioned above. The engagement of the latching lever with the trip hook is assisted by two tension springs, one on either side of the yoke. The steam inlet is above the valve seat and the outlet is below the seat; the disc therefore closes in the direction of the steam flow (not against the steam flow) and after having seated is held shut by the steam pressure.

Figure 2 shows the general relation of the principal parts. The tripping mechanism of the valve shown in Figs. 1 and 2 is actuated by a hydraulic cylinder under

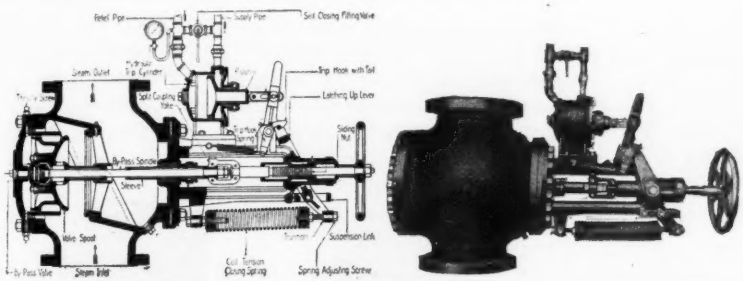


FIG. 1. EMERGENCY CLOSING VALVE IN OPEN POSITION

FIG. 2. EMERGENCY CLOSING VALVE SHOWING RELATION OF PRINCIPAL PARTS

25 to 75 lb. water pressure. The mechanism can, however, be electrically operated on 125 or 250 v. direct current.

The operation of the valve is as follows (see Fig. 1): Assume that a pipe rupture occurred on the outlet side of the valve, or that the steam pressure has dropped below the minimum allowable boiler operating pressure. This in turn will cause a diminution of hydraulic pressure in the relief pipe, thereby causing the piston in the hydraulic trip cylinder to be moved to the left. Under these conditions the latching up lever is disengaged and the unbalanced steam pressure acting on the top of the main valve disc and the non-rotating valve spindle closes the valve instantly. The closing is assisted by the coil tension closing spring.

To open the valve, it is first necessary to turn the hand wheel in a clockwise direction, whereupon the sliding nut is moved toward the valve body and the latching up lever re-engaged with the trip hook. Thereupon turning the hand wheel in a counterclockwise direction forces the disc off its seat and opens the valve.

A typical arrangement of the valve having a hydraulic trip cylinder release has four methods of distant control. The water in the hydraulic trip cylinder and relief pipe is ordinarily under 25 lb. gage pressure, and is taken from the city main or from the discharge side of the boiler feed pump. It is introduced into the system through a self-closing valve that is closed as soon as the relief pipe has been filled. There are four methods of distant control provided respectively by a number of latch lever valves in the relief pipe, a diaphragm controlled relief valve operated by steam pressure in the steam pipe serving the turbine, a second such relief valve operated by the overspeed governor, and a third relief valve actuated by the pressure of the lubricating oil.

The latch lever valves are normally closed and are hand operated. Any number of them can be installed. If a latch lever valve is opened, a flow of water occurs

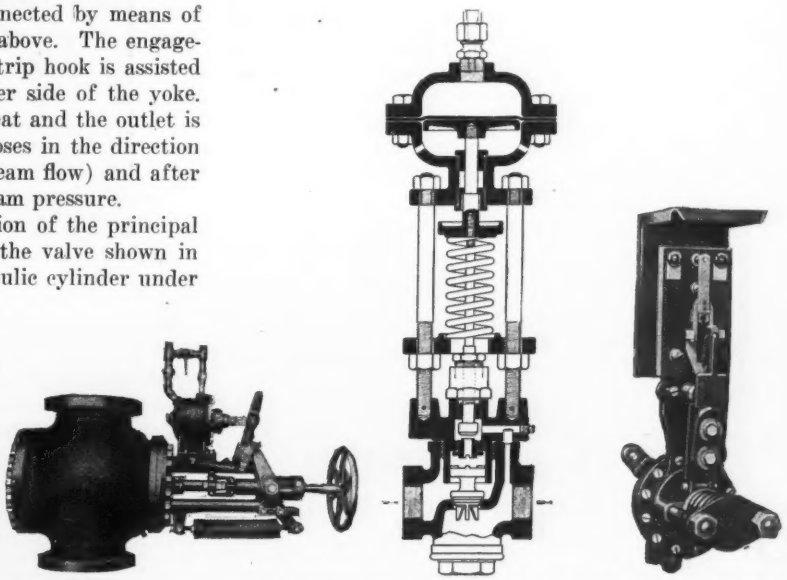


FIG. 3. DIAPHRAGM CONTROLLED RELIEF VALVE FOR ACTUATING EMERGENCY CLOSING VALVE

FIG. 4. DIAPHRAGM TYPE CONTACT BREAKER

in the relief pipe, thereby diminishing the hydraulic pressure to the left of the piston in the trip cylinder, releasing the latching up lever and tripping the emergency closing valve.

The diaphragm controlled relief valves are of the type shown in Fig. 3. A diminution in pressure in the chamber above the diaphragm permits the spring to rise and to open the valve, thus permitting a flow of water to occur through the bottom of the valve.

Ordinary cocks are installed on the relief piping on either side of each of the diaphragm controlled relief valves. These cocks are normally open. When the overspeed governor of the turbine is to be tested, when steam pressure is being built up, or oil pressure is being built up, the cock immediately before each diaphragm valve is open, but the other one is closed. These cocks also permit inspection or removal of the diaphragm valves while the turbine is in operation.

The emergency closing valve is adapted for use with various methods of control in addition to the one described above. In the so-called closed circuit direct

current type, 125 to 250 v., an electro-magnet is utilized the armature of which is a swing weight that, when the circuit through the magnet is broken, drops and trips the closing valve shut. Current flows continually through the electro-magnet, one or more self-closing push switches, a diaphragm contact breaker (the contents of which are normally closed), actuated by the steam pressure, through a second diaphragm contact breaker actuated by the lubricating oil pressure, and finally through a switch on the turbine throttle trip valve. The electro-magnet, push switches, contact breakers, etc., are all connected in series.

Contacts of the switch on the throttle trip valve are normally closed. They are broken by the tension rod of the overspeed governor when the turbine overspeeds. Under these conditions, not only does the turbine throttle trip valve close, but inasmuch as the switch is opened, the emergency trip valve is also closed.

Here, as in the other arrangement, four methods of distant control are available, of which any one or all can be used. Three indicating switches are ordinarily installed for short circuiting the contacts of the diaphragm circuit breakers so that the overspeed governor can be tested when necessary, or the oil pressure and steam pressure can be built up without tripping the emergency closing valve.

One type of diaphragm contact breaker is shown in Fig. 4. This is merely a device whereby a diminution in pressure is utilized to cause a movement of the diaphragm to open an electric circuit, thereby breaking the circuit through the magnet of the emergency closing valve, releasing the swing weight, and tripping the valve shut.

A Direct Reading Resistance Thermometer

RESISTANCE THERMOMETERS have certain notable advantages as compared with other temperature measuring devices which make them particularly valuable for many industrial processes. One particular advantage is in the ability to produce a high temperature instrument in which the whole temperature scale may cover a range of 25 deg. F. only.

The fundamental principle of the resistance thermometer is the well-known physical property of metals, except special resistance alloys, of change in resistance with change in temperature. This change in resistance can be accurately measured and a scale calibrated in temperature degrees.

The bulb or coil of wire which changes in resistance is usually of nickel for temperatures to 300 deg. F. and of platinum for higher temperatures to 1800 deg. F. The dimensions of the bulb can be very small to secure sensitivity. A nickel wire bulb can be supplied with active part 1 in. long and 3/16 in. diameter. This can be supplied in a protecting tube for moderate temperatures with an outside diameter of only ¼ in.

Three wires lead from the bulb to the instrument. This three wire system eliminates any effect on the indications of the instrument due to changes in temperature along the wiring connecting the bulb to the instrument. The length of wiring is immaterial in the Brown three-wire system and bulbs can be placed up to 1000 ft. distant from the instrument using No. 14 gage copper wire or up to 2500 ft. distant with No. 10 gage copper wire.

A recent development by the Brown Instrument Co. has been the perfection of a direct reading resistance thermometer. For years resistance thermometers have been built on what is known as the zero or null basis.

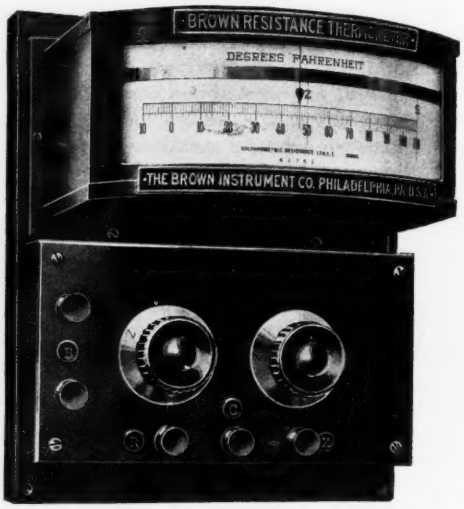
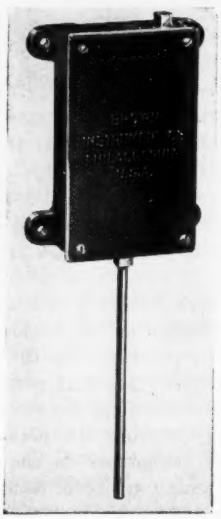


FIG. 1. BROWN DIRECT READING RESISTANCE THERMOMETER

In this type of instrument a galvanometer pointer must be brought to zero and a reading is then taken on a scale mounted in front of a rheostat. While quite accurate this method has the disadvantage of not being direct reading and the operator must obtain a balance by adjusting the slide arm of the rheostat so that the galvanometer indicates zero before the temperature reading is secured.



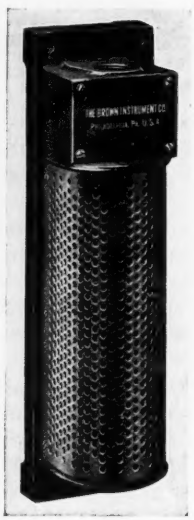


FIG. 2. BULB FOR USE IN DAMP PLACES
FIG. 3. ROOM BULB

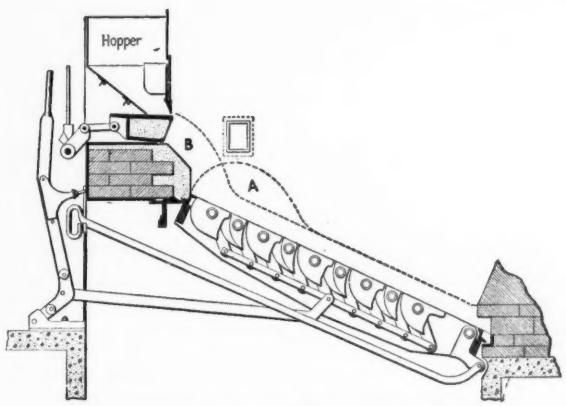
The Brown direct reading resistance thermometer has a scale graduated directly in temperature degrees as illustrated. To check the instrument for zero reading,

the left hand knob is turned to Z, and then to S to check the instrument with a standard resistance at the top graduation on the scale, and in the third position the instrument is operated directly off the temperature bulb. The rheostat is the right-hand knob on the instrument for adjusting the voltage. This check of the instrument, while recommended daily, need only be made every few days even where dry cells are used to operate the instrument, since the current required is infinitesimal, and dry cells last 4 mo. without replacement. Where storage batteries are used, a less frequent check is satisfactory.

Through means of a switch, the instrument can be connected to any number of resistance thermometer bulbs installed in different locations. Where used in dry kilns the instrument can be used to measure both temperature and humidity, one bulb being subject only to the air temperature, the second bulb being covered by a wick leading into a tank of water. This type of bulb, for measuring humidity, affords a means of instantly reading the difference in temperature of both the wet and dry bulbs and from suitable tables the per cent of humidity is available. This construction enables the measurement of both temperature and humidity at great distances.

CoKal Hand Stoker Adds Hopper Feed

IN ORDER to eliminate hand firing and make possible the receiving of coal directly from overhead bunkers, a hopper feed has been added to the hand-operated stoker, manufactured by the CoKal Stoker Corp., Chicago. Capacity and efficiency of the stoker are increased by this improvement. The necessity of opening and closing firing doors, which lowers efficiency by permitting



SECTION THROUGH IMPROVED COKAL STOKER

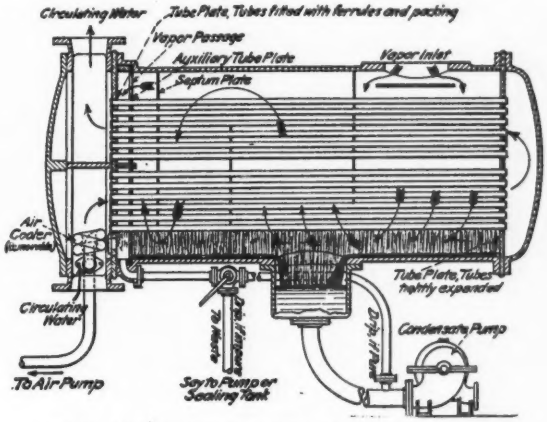
an inrush of excess air, is done away with. With the hopper feed, there is no necessity for opening furnace doors, for the fires are self-cleaning.

As shown in Fig. 1, the active stoker surface is increased by the hopper arrangement. When hand-fired, if the fireman is not extremely careful he is likely to carry the pile of fresh coal farther back than is necessary, as shown by the line A. Thus the active incandescent area of the fuel bed will be reduced and a tendency will be created for at least a part of the volatile matter to pass off unburned. With the hopper feed, however, the fresh coal from the hopper takes the contour indicated by the dotted line B. The coking of the coal takes place over what was formerly the firing door arm. Efficiency and capacity are increased and action is further helped by the introduction of a 2-in. flat arch that is installed with the hopper-feed stoker.

Figure 1 shows how hand-operated feeder gate blocks have been provided under the outlet from the hopper to force the coal into the furnace just as it is needed. These blocks are moved forward and backward by means of a small hand lever and serve three purposes. They act as valves to the hopper outlet, as coal pushers and as refractory seals to prevent the admission of air and the burning back of the coal into the hopper. The number of blocks used depends on the width of the furnace. Under a 1500-sq. ft. boiler three blocks are usually used.

Sidetracking Condenser Tube Leakage

TO PREVENT circulating water which may leak past tube end packings in a surface condenser from mingling with the condensate, S. Morris Lillie, of Philadelphia, has devised the double tube-plate construction illustrated herewith. At the right-hand end, the



LILLIE DOUBLE TUBE PLATE CONDENSER DESIGN

tubes are expanded into the plate, but at the left-hand end where tubes are packed to allow expansion, a second plate is provided on the steam side, through which the tubes make a close sliding fit.

Into the space between these plates any leakage around the packed tube ends passes, also any air that may leak through the inner joint of the tube plate; an opening is provided in the inner plate above the tubes through which any vapors may pass to be condensed on the tubes between the plates. This condensate and the leakage are taken off through a drip pipe at the bottom either to the main condensate pump or to waste, depending on the condition of the drip water, the disposal being controlled by a 3-way cock.

Gases from the inter-plate space are drawn off by a vent pipe near the bottom and passed through a cooling coil in the water space to the air pump.

At a little distance from the auxiliary tube plate is a septum plate, touching the shell from the top nearly to the bottom, behind which vapor and super saturated air passes up to the opening to the inter-plate space, thus providing additional cooling of air and insuring complete condensation of steam.

If desired a double plate construction may be used at each end, and the tubes secured to both main tube plates with ferules and packing, thus making renewal easier.

Mr. Lillie expects to sell the right to use this device to purchasers of condensers, allowing them to have the condensers made by almost any builder they may select.

Stow Radial Flexible Grinder

FOR the operation of abrasive wheels and wire scratch brushes on machine parts that cannot readily be handled on a stationary wheel, this new flexible grinder, recently put on the market by the Stow Manufacturing Co., fills a need in machine and repair shops.

APPLICATION OF STOW GRINDER

The tool is driven by belt from the line shaft through a flexible shaft and is particularly advantageous in shops having line shafting but no individual motor drive.

Being of the suspended type, the tool takes up no floor space and works in a circle limited only by the length of the extension arm which, together with the flexible shaft, is counterbalanced by a weight. This arrangement gives freedom to the operator in carrying out his work. The tool may also be used for drilling, boring, working screwdriver and similar services.

Increase in Power Output from Utility Plants

STATISTICS prepared by the United States Geological Survey of the Department of the Interior on the kilowatt-hours of electrical energy developed, indicate that since the beginning of the year the output has been larger than ever before, exceeding, in February, by about 5,000,000 kw.-hr. per day the record of 1920 for this month, and about equaling the maximum reached in any month, namely, about 125,000,000 kw.-hr. per day average for December, 1919. These figures include energy developed by both water power and fuels, including coal, oil and gas.

Of an average of about 122,500,000 kw.-hr. per day, for the first four months of this year, approximately 45,000,000 kw.-hr. or about 37 per cent was developed by water power. It is of interest to note that the difference in production of this year and 1920 is made up largely by water power, the increase in output of steam driven units being but a small amount, not in excess of 1,000,000 kw.-hr. a day. That increasing use is being made of our water power possibilities, there is no doubt. In Wisconsin, for example, the energy developed during March of this year was almost twice as much as during February. The figures stand 48,167,000 as against 24,515,000 kw.-hr. This increase, however, was due largely to an increase in demand, as the reduction in power produced by fuels amounted to only about 1,500,000 kw.-hr. The difference in the number of days in the two months considered would alter somewhat the conclusions to be drawn, but the fact remains that in February the energy developed by water power in this state constituted about 35 per cent of the total, and in March about 52.5 per cent. This increase is due largely, however, to the increase in potential water power from February to March.

News Notes

THE ANNUAL convention of the Illinois State Association of the National Association of Stationary Engineers was held in Chicago from June 7 to 10. The many-colored balloons and feathers, the whistles, and the other usual convention accessories made the Municipal Pier a lively place for the four days.

The Wisconsin association sent down a special trainload of delegates which descended on the convention the afternoon of the last day to the tune of "On Wisconsin" played by their saxophone band.

At the morning session of the last day, June 10, the following officers were elected for the coming year: President, A. C. Frantz, Moline, Ill.; vice-president, J. C. Rounds, Springfield, Ill.; secretary and treasurer, S. H. Raven, Chicago, Ill.

M. E. Harris, of Chicago, was recommended for National Deputy. Mr. Harris has been State Deputy for 3 yr.

Retiring President Fred Gielow was presented with a jeweled badge of past masters in recognition of service rendered during his term of office.

A spirit of enthusiasm prevailed among the delegates, and the convention was adjudged a success for the visitors, exihibitors, and from a financial point of view. Plans are under way to make the meeting next year at Springfield, Ill., still bigger and better.

JOHN F. SCHURCH HAS been elected a vice-president of Manning, Maxwell & Moore, Inc., and on June 1 took charge of the company's western sales, with headquarters at its Chicago office.

HEYL & PATTERSON, INC., of Pittsburgh, who were in the pulverized coal equipment business for several years and who had since the death of E. C. Covert temporarily suspended this class of work, have re-entered the field by placing C. F. Herington in charge.

FREDERICK D. HARGER, vice president and general manager of the Mono Corporation of America, has resigned from this company and has accepted a position on the sales staff of the Chas. J. Tagliabue Mfg. Co., Brooklyn, N. Y.; the latter company having taken over

all the rights for the manufacture and sale of Mono apparatus in North America.

J. G. BARRY, sales manager of the General Electric Company since 1917, and manager of its railway department for many years, and A. H. Jackson, of the law department, were recently elected vice-presidents of the company at a meeting of the board of directors.

THE MENGE MARINE HARDWARE & SUPPLY CO., of New Orleans, recently suffered a complete loss of their stock and warehouse and have decided to go out of business and the Globe Supply & Machinery Co., of New Orleans, La., will now act as sole distributor for the Metric Packing Co. in the states of Louisiana and Mississippi.

THE FULTON CO. announces a reorganization of personnel. Mr. Brown, the former treasurer, has disposed of his interests to W. M. Fulton and Warren Webster & Co., and has retired. The new officers of the company are W. M. Fulton, president and treasurer; Warren Webster, vice-president; C. N. Mynderse, executive manager, and Henry Hudson, secretary.

PARTNERSHIP has been established in Chicago between J. M. Kryl, at present president of the Kryl Bridge and Crane Works, Chicago, and W. H. Eichelman, until recently chief engineer of the Hamler Boiler & Tank Co. The firm will handle fabricating of steel plate and structural iron for water tanks, oil tanks, stacks, process kettles of all kinds for chemical equipment, ornamental iron and structural steel.

THE PITTSBURGH Testing Laboratory announces the opening of a sales office with a complete inspection bureau, in Railway Exchange Building, St. Louis, Mo., and the appointment of N. C. Hoyles as district manager and Harry M. Wey as manager of the Chicago district with office located in the Monadnock Block.

THE NIAGARA FALLS POWER CO. has placed an order with the General Electric Co. for two 65,000-kv.a. 12,000-v. vertical waterwheel generators, the largest ever built, to be used in an extension to its Power House No. 3, at Niagara Falls, New York. These generators will be driven by 70,000-hp. hydraulic turbines made by the I. P. Morris Dept. of The William Cramp & Sons Ship & Engine Building Co. Each generator will weigh 700 T., being 35 ft. in diameter and 26 ft. high. It is interesting to note that the new generators are twice the capacity of the three 32,500-kv.a. generators now contained in Station No. 3, which at the time of their installation were considered the largest in existence.

THE TITAN IRON & STEEL CO., INC., Newark, N. J., has announced the appointment of W. Woodward Williams as vice-president.

Mr. Williams started his career in the mills of the Carnegie Steel Co. at Pittsburgh, Duquesne, and Youngstown; entered the sales department of the Bourne-Fuller Co., of Cleveland, and was later appointed manager of its Pittsburgh office; he became general manager of sales of the A. M. Byers Co., Pittsburgh, and subsequently was made its general manager; was general manager of the Reading Iron Co., and afterward was elected vice-president, in charge of sales and operations; in September, 1920, he became associated with the Pittsburgh Gage & Supply Co., resigning the vice-presidency of this company on May 31, 1922, to enter upon his present office.

NOW THAT the boring of the 6 mi. Moffatt tunnel in Colorado will start about Sept. 15, a power house and machine shop must be built first. The present plans are that these plants are to be erected during August. Major L. D. Blauvelt, the engineer who served as chief engineer of the Denver and Salt Lake Railroad for many years, and at present chief engineer of the Colorado Highway Association, has been selected as chief engineer of the construction board in charge of the tunnel work. Six hundred men will be employed and it is conservatively estimated that the time necessary to complete the tunnel is 3½ to 4 yr. Denver, Colo., is the present location of the chief engineer.

THE LARGEST single consignment of electrical apparatus for railroad electrification ever made was shipped recently from the works of the Westinghouse Electric & Manufacturing Co. The shipment, which represented the first consignment of electrical equipment for the electrification of the Chilean State Railways, consisted of 32 cars and was about 1300 ft., or almost a quarter of a mile long. It was one of the longest trains that has ever left the Westinghouse plant with a consignment of material covered by one contract. The shipment included two complete sub-station equipments for supplying power at 3000 v. direct current to the Chilean State Railways, which is now being electrified. Each sub-station includes motor generator sets, transformers and switching equipment. The remaining sub-station equipment will be shipped within the next 30 days, and the shipment of the locomotives for the electrification, 39 of which are included in the order, will commence in July.

The shipment will go direct from East Pittsburgh to the Eddystone Docks of the Baldwin Locomotive Works at Philadelphia, where it will be loaded into a big ocean-going freight steamer and shipped from there to Valparaiso Harbor, Chile.

U. S. CIVIL SERVICE COMMISSION announces examinations, July 19 and Sept. 6, for Junior Aid, Grade 1 ($540 a year) and Junior Aid, Grade 2 ($720 to $840 a year). These examinations cover positions included in the usual entrance grades of the scientific and technical staff of the Bureau of Standards, Department of Commerce, and preference in appointments will be given to those who state in their applications that they intend pursuing a scientific career. Vacancies in the scientific staff of this bureau, for duty in Washington, D. C., and in positions requiring similar qualifications, at the entrance salaries indicated, will be filled from these examinations. Appointees whose ability and qualifications justify such action will also be allowed any bonus granted by Congress (at present $20 a month) in addition to the above salaries, beginning with the second month of acceptable service. Competitors will be rated on elementary algebra and geometry, elementary physics or chemistry, mechanical drawing, education and experience. Apply for Form 1312, stating examination title.

U. S. Civil Service Commission announces an examination for Gage Checker, receipt of applications to close July 18, to fill a vacancy at Picatinny Arsenal, Dover, N. J., at $1800 a year, and vacancies in the Ordnance Department at Large throughout the United States, and other branches of the service requiring similar qualifications, at this or higher or lower salaries. Competitors will be rated on education, preliminary experience, and experience in the manufacture or inspection of gages. They must have reached their eighteenth but not their sixty-fifth birthday on the date of the examination. In view of the retirement act, should the appointing officer so request certification will not be made of eligibles who have reached their fiftieth birthday. Apply for Form 1312, stating examination title.

Books and Catalogs

Burning Liquid Fuel by W. N. Best; size 6 by 9 in., 341 pages, cloth; New York, 1922.

The science or art of burning liquid fuels, such as crude oil, fuel oil or tar, is much more complicated than it might appear to be on the surface, to the average fireman or engineer. The question is not merely one of forcing a jet of oil into the furnace—far from that. To evolve a successful installation the designer must be familiar with and fully appreciate all the factors entering into the design. Theory alone is not sufficient but must be supplemented by a knowledge of facts brought to light by practical experience.

The author has brought out these facts and has shown their relation to theory. As no two kinds of installation will have to meet the same conditions, he has discussed the use of oil fired furnaces for any number of different purposes from steam boilers to cement, enameling, heat treating, bread ovens, etc.

The book is bountifully illustrated with views and drawings of typical illustrations. The whole forms a valuable addition to the available literature on this subject.

While the properties of concrete have been investigated for many years, attention has largely been given to considerations of strength alone. Aside from the action of direct load, deformations are produced in concrete by changes in temperature and in moisture content. With reference to temperature changes in reinforced concrete, it is well known that concrete has practically the same coefficient of expansion as steel, so that the two materials contract or expand together. Moisture content, on the other hand, has the undesirable property of affecting concrete alone. Concrete, like wood, clay, and some other materials, expands when it absorbs moisture, and contracts when it is dried. Steel has no such action.

Bulletin No. 126 of the Engineering Experiment Station of the University of Illinois, entitled "A Study of the Effect of Moisture Content upon the Expansion and Contraction of Plain and Reinforced Concrete," contains some of the results of experiments made by Torata Matsumoto, a graduate student in Theoretical and Applied Mechanism at the University of Illinois, in 1918. Owing to his years and experience as an engineer on harbor works on the Island of Formosa, he was particularly interested in the question of durability of concrete exposed to sea air and to the conditions found in a tropical climate. It is felt, however, that the results obtained apply to our ordinary conditions and may have many practical applications.

Copies of this Bulletin No. 126 may be had without charge by addressing the Engineering Experiment Station, Urbana, Ill.

Here's What "Happens" is the title of a booklet relating to Dearborn feed water treatment, just issued by Dearborn Chemical Co., Chicago.

Thwing radiation pyrometers, indicating and multiple-recording types, are the subject of Bulletin No. 11 of Thwing Instrument Co., Philadelphia.

Descriptive leaflet 3443, issued by the Westinghouse Electric & Mfg. Co., describes its new luminous top holder socket reflector.

Preventing Corrosion of Boiler Tubes is the title of a bulletin just issued by the National Tube Co., in which the causes of corrosion of boilers in various services and modern methods of prevention are discussed.

Small steam turbines suitable for driving condenser auxiliaries, exciters, small generators, etc., are described and illustrated in Bulletin No. 1123, just published by Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

Type QC-3 quick break lever switches up to 600 v. and 1000 amp. are described in Bulletin No. 47,326 just issued by the General Electric Co. These switches are made in either single, double, triple or four-pole combinations for single or double throw.

The Conveyors Corporation of America, Chicago, have issued an illustrated booklet entitled, "Cut Ash Handling Costs," which is an exposition of the steam jet conveyor method of ash handling and contains a description of the conveyor and its method of operation.

A booklet just issued by the Combustion Engineering Corporation relative to the powdered coal installation at the River Rouge plant of the Ford Motor Co., is in substance a reprint of a previous Ford booklet, but contains some very interesting information on operating results at this plant, which has been in operation slightly over a year. It is worthy of note that one of the boilers has been up to 425 per cent of rating for a short period which represents considerably over 10,000 hp.

The Pelton Water Wheel Co. has issued a 16-page illustrated booklet entitled "The Kern River Number Three Plant of the Southern California Edison Co.," written by Ely C. Hutchinson, general manager of the Pelton Co. The hydraulic prime-mover equipment for this plant is particularly notable, since it comprises two 25,000-hp. Pelton vertical turbines, operating under a head of 810 ft., the highest head reaction turbines in the world. In addition, certain special operating requirements called for various novel features in the design of both turbines and accessory apparatus. Copies of the booklet may be obtained from either the San Francisco or the New York office of the company.